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Investigation of the Formation of a Portland Cement Plant Detached Plume

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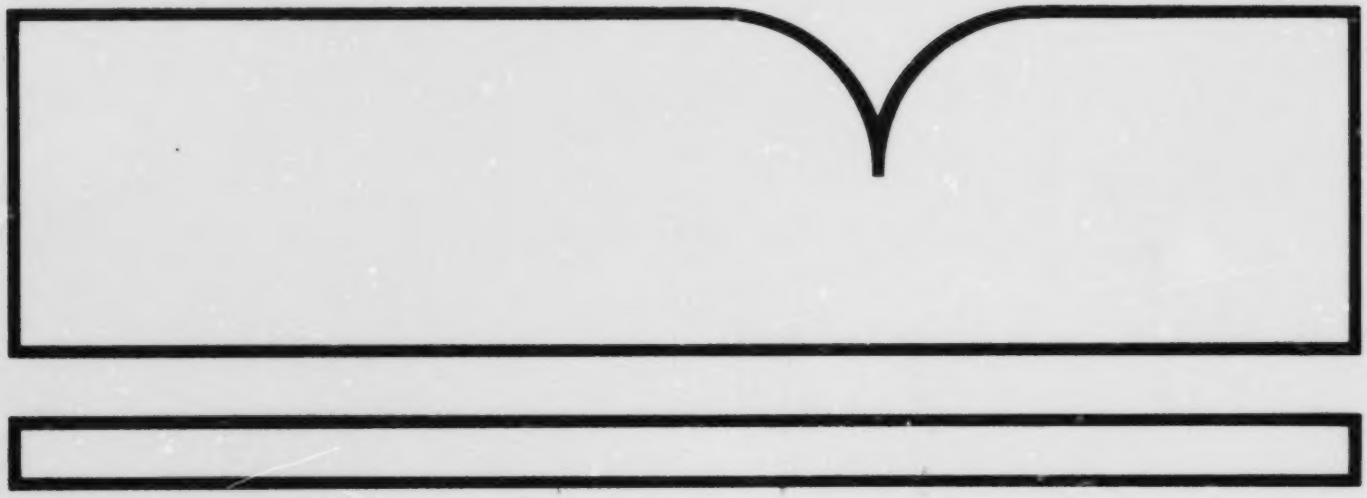

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INVESTIGATION OF THE FORMATION OF A PORTLAND CEMENT PLANT DETACHED PLUME

by

James L. Cheney and Kenneth T. Knapp

Emissions Measurement and Characterization Division
Atmospheric Sciences Research Laboratory
Research Triangle Park, North Carolina 27711

ATMOSPHERIC SCIENCES RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

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The sampling and analysis program included particulate emissions measurements, particle sizing and composition, and measurements of gaseous and particulte ammonia, chloride, fluoride, and sulfur dioxide. Extensive process materials sampling and analysis were also conducted.

Based on the resulting data one conclusion is that the opaque detached plume is the result of ammonium chloride particles formed by the reaction of gaseous ammonia and hydrochloric acid.

It was also found that the ammonia in this cement plant was generated from the shale portion of the raw products when the raw product was passed through the heat exchanger.

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SECTION 1

INTRODUCTION

Source emissions which have low opacity while in the stack, but develop high opacity in the plume continue to cause enforcement difficulties. Historically, the Portland Cement production plants have been the most obvious with this detached plume problem. Regional[1] EPA Offices have also had the same difficulties with some coal and oil fired power plants. All these plants pose the persistent enforcement difficulty of how to require effectively a plant to lower the visible emissions in a plume when that plant's instack particulate and opacity standards are in compliance.

The Stationary Sources Emissions Research Branch (SSERB) of the Atmospheric Sciences Research Laboratory (ASRL) has responded to several Technical Assistance requests from Regional Offices to investigate such plants A source-plume sampling program at a Glens Falls, New York cement plant led to the conclusion[2] that ammonium sulfate particles were responsible for the high opacity plume at the plant. The problem usually diminished when water droplets did not form in the plume; hence a solution-chemistry formation of ammonium sulfate salts from gaseous ammonia and sulfur dioxide was suggested. The kiln at the Glens Falls plant was fired with residual fuel oil.

A second cement plant was the objective of a study[3] conducted in response to a technical assistance request from EPA Region Four. This plant, located at Leeds, Alabama was a coal-fired kiln with a highly opaque plume which formed several stack diameters down wind of the mouth of the stack. Unlike the oil-fired plant at Glens Falls, the Leeds plant had the detached

plume only when the plant operated in a bypass mode. During that mode, raw products and fuel did not change, however, the kiln emissions were passed through a cooling tower in lieu of the raw product mill and then through an electrostatic precipitator. Sampling at the Leeds plant included both source particulate and gaseous emissions and plume sampling with a tethered balloon. Both the source and plume samples suggested that the plume opacity was caused by the formation of ammonium chloride particles. These particles most likely were the result of the gas phase reaction of ammonia and hydrochloric acid, both emitted from the stack.

For both of the sources, the presence of ammonia in the emissions played a role in particle formation in the plume. This has led to speculation[4] as to the source or mechanism of formation of ammonia in Portland cement plants, as well as it's effects on particulate sampling methods[5].

This report involves a third portland cement plant that also has difficulties with the formation of a detached highly opaque plume. The plant is located in Rapid City, South Dakota and uses a Western coal to fire a dry process kiln. This plant has a persistent plume which is more opaque when the raw product mill is not operating, the bypass mode.

A two week sampling program was conducted which involved source emission sampling for both particles and gases. Process samples and operating parameters were obtained during the sampling period. This report describes the details of that sampling program, including the plant description, methods used for sampling and analyses, the resulting data and the conclusions concerning the formation of the particles in the plume.

SECTION 2

DESCRIPTION OF THE PLANT

The South Dakota Cement (SDC) Plant is owned and operated by the state of South Dakota and is located just north of Rapid City, SD. In 1985 the plant production was 672,700 tons of portland cement. The process uses 4 basic raw materials, limestone (80%), shale (12%) sand (5%) and iron ore (2%). The limestone is acquired from an onsite mine. The shale is mined at a site located within 5 miles of the plant site and transported to the plant by trucks. After the limestone is brought in from the initial crushing, it is combined with the shale, sand and iron ore and conveyed by belt to a Loesch Mills as "raw feed". The plant uses this raw feed to produce portland cement by a dry process. The plant also produces portland cement by a wet process from a separate raw feed. Since the wet process at this plant has no plume problem, the process described below will be confined to the dry process.

A schematic of the process flows for the dry process is shown in Fig. 1. This process can involve two operating mode; when the Loesch mill is on and grinding raw feed (MON), and when the mill is off (MOF). After passing through the Loesch mill, the raw feed now pulverized, is transported to blend silos as kiln feed. To load the kiln, this feed is passed down through a four stage cyclone heat exchanger, then into the kiln. Flowing counter current to the kiln feed are the emissions from the coal combustion, which rise up through the heat exchanger, and pass through the Loesch mill, when the mill is operating. When the mill is off, the kiln emissions bypass the mill. Following the mill or bypass system, the emissions pass through

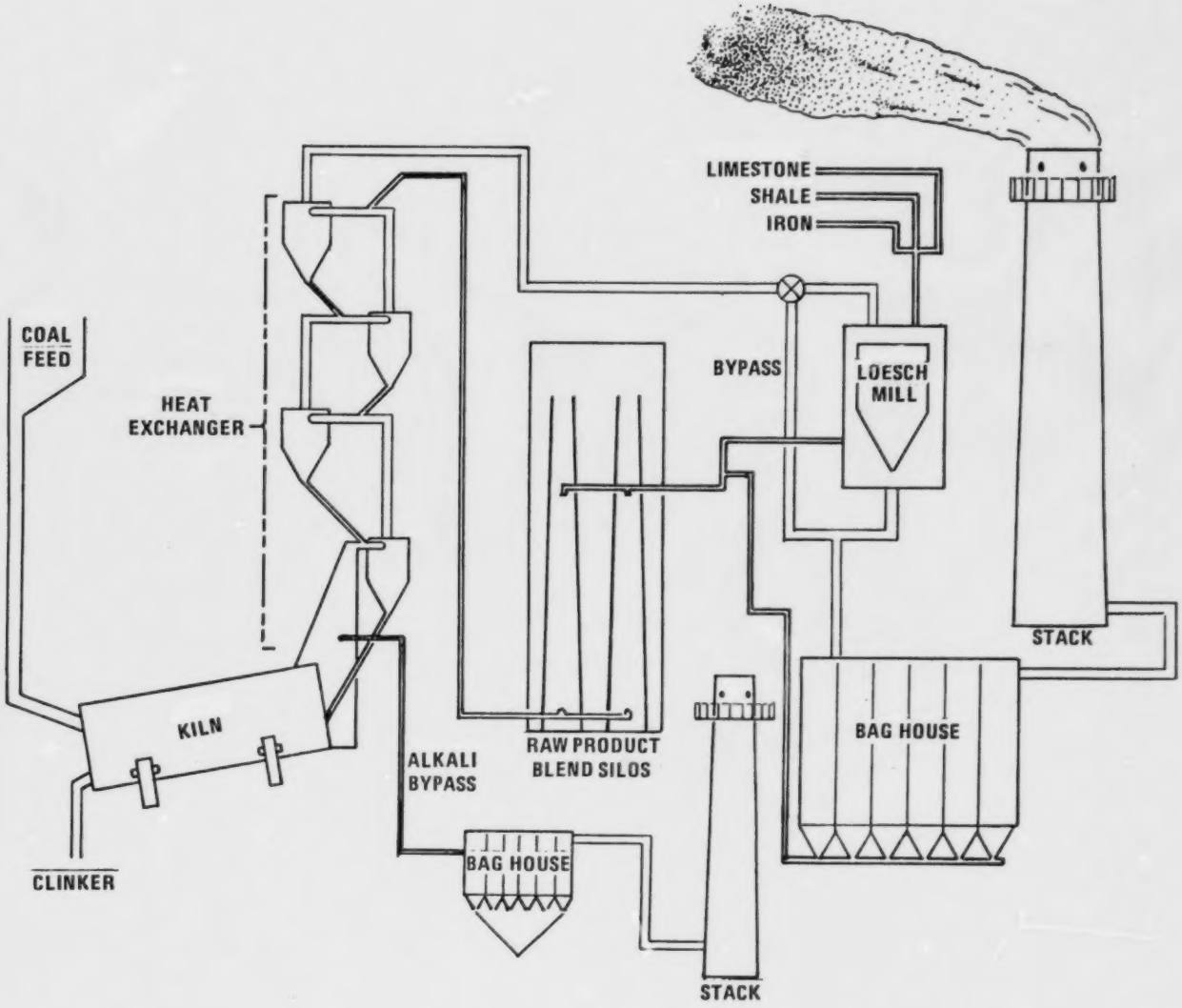


Fig. 1. Depiction of Process Flows for Dry Process Cement Production

the baghouse, and out a 100ft tall stack. The material collected in this baghouse is returned to the blend silos for kiln feed.

The heat exchanger serves two purposes, to heat the kiln feed to 1900°F before it enters the kiln and to cool the kiln emissions to a nominal 600°F prior to its entrance into the mill. When the mill is in operation, the kiln emissions are further cooled to a nominal 350°F. In the absence of mill operation, the kiln gases pass through the baghouse at a nominal 550°F.

An alkali bypass system serves to remove some of the highly alkaline components which would decrease the quality of the final product. The system extracts a portion of the kiln emissions as they exit the kiln at 1900°F. This fraction of the emissions is filtered, after cooling, in a separate baghouse. The solids are disposed of as landfill, while the gases are vented to the atmosphere via a separate stack.

When full, the silos can provide a nominal 48 hours of kiln feed without the mill operating. During the study program, switching the mode of operating was dictated by kiln feed supply. The emissions from this dry process can produce a detached opaque plume during both operating modes, however the greatest plume opacity is in the mill off mode.

SAMPLING METHODS

A wide variety of extractive sampling methods were used to measure the particulate and gaseous emissions. The mass emission rates of particulate matter were determined with a modified version of the EPA Reference Method Five (MM5). Three different solvents were used in the impingers of the MM5 train, a 3% hydrogen peroxide for measuring the sulfur dioxide emissions, a

0.1N sulfuric acid solution for collecting ammonia, and a 0.1N sodium hydroxide solution for collecting hydrochloric and hydrofluoric acids. All impinger systems were maintained at ice bath temperature during sampling. Different filter media and filter temperatures were used amoung the various tests in order to assess particulate gas equilibrium in the emissions. Either glass (Reeve Angel type 934AH)or quartz (Pallflex, type 2500 QAST) filters were used in the MM5 sampling train. The MM5 impingers were preweighed and reweighed after sampling to quantify the amount of moisture in the emissions. The probe nozzles used throughout the study were 3/16 inches in diameter.

Sampling for particulate and gas phase ammonia, chloride and fluoride was conducted with a special particulate and gas sampling (PAGS) train. This prototype sampling system is a modified version of a previously described miniature acid condensation system[6]. The system used for this project had a variable temperature controlled probe and 47mm filter holder not used on early versions which had a preset temperature controller. Following the filter were three impingers containing either 0.1N H_2SO_4 or 0.1N NaOH. A 5/32 inch nozzle was used for the PAGS sampling system in this study. All samples were collected on Pallflex, type 2500 QAST quartz filters.

Particle sizing was performed by sampling with impactors. The impactors were University of Washington Mark III (Pilat) seven stage impactors with a quartz backup filter. A limited number of plates with grease substrate were used due to the high temperature of the emissions. A majority of the impactor runs were with precut and preweighed quartz (QAST-2500) substrates. During recovery,some quartz filters were not held for reweighing but immediately placed in a 0.1N H_2SO_4 solutions to prevent loss of ammonia. Impactor samples were collected both instack and in a temperature-controlled heated

box external to the stack.

Several types of filter media were used to collect source particles for particulate characterization. Glass fiber filters (Reeve Angle 934AH), a Teflon (1 m Schleicher & Schuell), Nuclepore (1 m) and quartz (Pallflex QAST 2500) were used for both operational modes. Characterization samples were collected by extracting the emissions through a heated probe to the filters in a heated box.

Feed stock samples were collected from each section of the raw feed process, blend silos, heat exchanger, alkali bypass, for both mill and bypass modes. The solid samples were placed in tightly closed containers and stored at ice temperature or refrigerated until analyzed.

All extractive samples were taken at points of average stack gas velocity as determined from pitot tube traversing.

RESULTS OF SOURCE SAMPLING

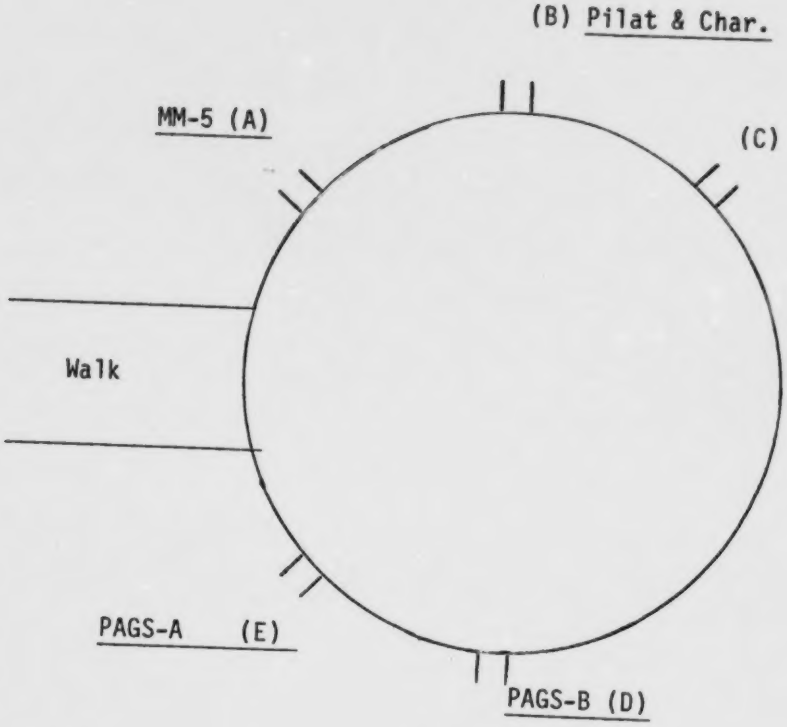
A total of 11 MM5, 2i particulate and gas samples (PAGS), 14 University of Washington impactors samples and a large number of particulate characterization samples were collected from the dry process emissions on 7 separate days. Six sampling periods were conducted in the bypass operation mode and were conducted during the Loesch Mill operation mode. The extractive sampling port arrangement and an example of a series of velocity traverses are shown in Fig. 2. All sampling was conducted from the respective points 1.5 ft inside the stack.

During each day of sampling, important temperature and feed rates were recorded hourly throughout the sampling periods. The average temperature and feed rates are given in Table 1. The four heat exchanger temperatures are

recorded at the bases of the cyclones as feed stock moves downward toward the kiln. No discernible differences between any location could be found that can be attributed to operation mode. The average coal feed rates and kiln feed rates are 13.3 and 108 tons/hrs for the MOF mode and 14.6 and 117 tons/hr for the MON mode respectively.

Sampling with the MM5 and PAGS was done in corresponding sets. The samples actually acquired by the 3 systems are shown in Table 2. Most of the MM5 samples involved hydrogen peroxide (3% H_2O_2) in the impingers for collection of sulfur dioxide. The PAGS sampling systems, with the exception of the last sample on June 13, were run in simultaneous pairs with respect to impingers contents.

Considerable difficulty was encountered when recovering the particulate matter from the probes of both the MM5 and PAGS trains. Acetone was used for probe washing. A white particulate matter which was suspected as being NH_4Cl and insoluble in acetone was collected in the probes. The results of the MM5 probe wash recoveries, in terms of emission rates of the ions determined, are presented in Table 3. Immediately apparent from the probe wash samples is the presence and significant amounts of NH_4^+ and Cl^-. The column of % NH_4Cl was calculated on the assumption that all NH_4^+ existed as NH_4Cl and excess Cl^- was attributed to other salts and HCl. For all samples except MM5-6 the average mole ratio of Cl^- to NH_4^+ was 1.2 to 1.0. For sample MM5-6 the NH_4Cl was calculated from the 25.61mg Cl^- assuming all Cl^- was NH_4Cl.



Port	A		C		E	
Traverse Point(ft)	P_s	°F	P_s	°F	P_s	°F
0.5	.48	459	.40	481	.39	470
1.0	.60	475	.44	485	.41	480
1.5	.63	481	.51	487	.48	483
2.0	.69	485	.56	485	.53	485
2.5	.72	485	.58	487	.55	486
3.0	.69	486	.61	487	.60	486
3.5	.66	486	.65	486	.68	486
4.0	.67	486	.69	486	.63	483
Averages;	.64		.56		.53	

Fig. 2 Stack Sampling Site and Velocity Traverse Results

TABLE 1. AVERAGE OPERATING PARAMETERS DURING SAMPLING PERIODS

Date	Heat Exchanger Temperatures (°F)				Coal Feed	Kiln Feed	L. Mill
Stages;	1st	2nd	3rd	4th	(tons/hr)	(tons/hr)	(tons/hr)
6/3	754	1133	130.	1408	13.4	105	MOF
6/4	754	1140	1330	1411	14.5	115	128
6/5	753	1136	1330	1417	14.5	116	126
6/6	750	1126	1297	1406	13.1	108	MOF
6/11	748	1129	1310	1407	13.5	109	MOF
6/12	741	1131	1332	1418	14.7	119	NA*
6/13	741	1118	1289	1403	13.2	111	MOF

*Not Acquired

Table 2 Samples Acquired for MM5, Ammonia, Chloride and Fluoride

DATE	Run Identification	Time of Day	Mole	Filter Type[1]	Filter Temperature (°F)	Impinger Solution	Sample Volume[2] (cu ft)
6-3-85	MM5-1	1659-1759	MOF	GF	400	3% H_2O_2	21.477
"	NH_3 (PAS)-1A	1657-1757	"	Q	480	0.1N H_2SO_4	16.707
"	NH_3 (PAS)-1B	1657-1757	"	Q	480	0.1N H_2SO_4	19.220
6-4-85	MM5-2	1331-1431	MON	GF	425	3% H_2O_2	26.323
"	HF/HCl (PAS)-1A	1329-1429	"	Q	360	0.01N $NaOH$	19.301
"	HF/HCl (PAS)-1B[3]	1329-1356	"	Q	360	0.01N $NaOH$	6.870
6-5-85	MM5-3	1053-1153	MON	GF	250	3% H_2O_2	24.258
"	HF/HCl (PAS)-2A	1049-1149	"	Q	360	0.01N $NaOH$	18.353
"	HF/HCl (PAS)-2B[3]	1049-1149	"	Q	250	0.01N $NaOH$	16.584
6-5-85	MM5-4	1718-1818	MON	GF	250	0.1N H_2SO_4	23.567
"	NH_3 (PAS)-2A	1720-1820	"	Q	360	0.1N H_2SO_4	17.944
"	NH_3 (PAS)-2B	1720-1820	"	Q	360	0.1N H_2SO_4	16.713
6-6-85	MM5-5	0950-1050	MOF	Q	250	3% H_2O_2	20.855
"	HF/HCl (PAS)-3A[3]	0950-1050	"	Q	360	0.01N $NaOH$	16.248
"	HF/HCl (PAS)-3B	0950-1050	"	Q	250	0.01N $NaOH$	15.160
6-6-85	MM5-6	1515-1615	MOF	GF	250	0.1N H_2SO_4	20.726
"	NH_3 (PAS)-3A	1516-1616	"	Q	360	0.1N H_2SO_4	15.554
"	NH_3 (PAS)-3B	1516-1616	"	Q	250	0.1N H_2SO_4	14.494
6-11-85	MM5-7	1120-1220	MOF	GF	250	0.1N H_2SO_4	20.708
"	NH_3 (PAS)-4A	1117-1217	"	Q	360	0.1N H_2SO_4	15.208
"	NH_3 (PAS)-4B	1117-1217	"	Q	250	0.1N H_2SO_4	14.647

Table 2 Cont.

6-12-85	MM5-8	1030-1130	MON	GF	250	0.01N N_aOH	25.806
"	HF/HC1(PAS)-4A(3)	(run aborted)	"	Q	360	0.01N N_aOH	-
"	HF/HC1(PAS)-4B	1030-1130	"	Q	250	0.01N N_aOH	18.574
6-12-85	MM5-9	1600-1700	MON	GF	250	3% H_2O_2	26.236
"	NH_3 (PAS)-5A	1600-1700	"	Q	360	0.1N H_2SO_4	20.611
"	NH_3 (PAS)-5B	1600-1700	"	Q	250	0.1N H_2SO_4	18.805
6-13-85	MM5-10	0830-0930	MOF	Q	250	0.01N N_aOH	20.470
"	HF/HC1 (PAS)-5A	0830-0930	"	Q	360	0.01N N_aOH	16.083
"	HF/HC1 (PAS)-5B	0830-0930	"	Q	250	0.01N N_aOH	14.507
6-13-85	MM5-11	1215-1315	MOF	GF	250	3% H_2O_2	20.323
"	NH_3 (PAS)-6	1215-1315	"	Q	250	0.1N H_2SO_4	16.133
"	HF/HC1 (PAS)	1215-1315	"	Q	250	0.01N N_aOH	14.389

(1) Glass Fiber (GF) and Quartz (Q)

(2) Volumes corrected to standard conditions

(3) Indicates sample runs affected by apparatus or electrical problems, results may be questionable.

TABLE 3 SUMMARY OF MM5 PROBE WASH ANALYSIS AND CALCULATIONS

Date	ID	T.Mass(mg)	NH_4^+(mg)	Cl^-(mg)	%NH_4Cl[1]	Emission[3] Rate	Adjusted[4] Rate	Mode
6-3	MM5-1	53.01	9.99	21.15	55.9	32.8	14.4	MOF
6-4	MM5-2	27.18	2.26	5.06	24.7	16.4	12.3	MON
6-5	MM5-3	35.75	4.43	9.77	36.8	21.4	13.5	MON
6-5	MM5-4	NM[2]	NM	NM	NM	NM	NM	MON
6-6	MM5-5	NM	NM	NM	NM	NM	NM	MOF
6-6	MM5-6	59.75	13.47	25.61	64.6	38.3	13.6	MOF
6-11	MM5-7	68.75	10.89	28.55	47.0	43.7	23.2	MOF
6-12	MM5-8	26.88	3.42	7.12	37.8	16.7	0.4	MON
6-12	MM5-9	29.73	2.81	6.21	28.1	18.3	13.2	MON
6-13	MM5-10	46.59	5.92	18.17	3.77	30.3	18.9	MOF
6-13	MM5-11	24.52	6.86	15.73	83.1	15.9	2.7	MOF
		Averages:			50.9	36.2	17.5	MOF
					31.9	18.2	12.4	MON

(1) Calculated from mg NH_4^+ x 53.45mgNH_4 Cl/18mg NH^+_4 and then divided by T. Mass
(2) NM = not measured, probe washes from MM5-4 and MM5-5 were erroneously mixed.
(3) Calculated from the total probe wash mass in lbs/hr.
(4) Emission rate less the NH_4Cl, in lbs/hr.

Samples MM5-4 and MM5-5 were not included in the calculations since the solutions were mixed during the acetone evaporation process. Sample MM5-11 was not included in the averaging of the MOF mode. If this sample is included in the MOF averaging results then the average % NH_4Cl probe wash particulate is 58.1% rather than the 51.9% this would result in an average adjusted MOF emission rate of 14.4 lbs/hr rather than 17.3 lbs/hr.

The MM5 filters were found not to have collected any significant particulate matter from the sampling and several of the filters showed negative weights. Those having positive weights contributed no more than a maximum of 1.3% to the total particulate catch. Table 4 shows the weights of the filters, the results from NH_4^+ and Cl^- analysis and the probe wash residue weights.

TABLE 4 MM5 FILTER WEIGHTS AND ANALYSIS

ID	Mass(mg)	NH_4^+(g)	Cl^-(g)	Probe Wash Mass(mg)
MM5-1	-1.606	5.3	134	53.01
MM5-2	-2.176	0.3	55	27.18
MM5-3	-0.424	1.3	66	35.75
MM5-4	0.090	NM	NM	NM
MM5-5	1.408	NM	NM	NM
MM5-6	0.219	1.3	150	59.75
MM5-7	-0.355	0.3	111	68.75
MM5-8	0.345	0.3	225	26.88
MM5-9	-0.060	0	48	29.73
MM5-10	0.288	6.3	283	46.59
MM5-11	0.026	1.3	110	24.52

The very small amount of NH_4^+ or Cl^- on the filters relative to the amount in the probe washings strongly suggest that substantially all of the particulate matter is formed in and collected by the probe.

The MM5 impingers catches were recovered and analyzed for the appropriate ions, as shown in Table 5. Since only 3 samples collected NH_4^+ in the impingers and 2 collected Cl^- and F^-, averages were not calculated for these components. Six samples had collected SO_2 therefore, an average was calculated for it. The limited amount of impinger catches that show NH_4^+ and Cl^- suggest that not all NH_3 and HCl form particulate matter, but pass the filter as gas phase components. The emission rates of NH_3, Cl^-, and SO_4^+ from the probe washes are also given in Table 5. Virtually no sulfate appears within the probe with essentially all of it on the filter.

Based on a 0.4% sulfur content of the coal and an average 13 tons/hr firing rate, an SO_2 emission of 208 lbs/hr can be projected. Since the maximum amount collected in the impingers was during the MOF mode and averaged a nominal 131 lbs/hr, this low collection suggests that the kiln feed acts as an SO_2 sink even in the absence of the raw feed from the Loesch Mill. When the Mill is operating, nominal average of 70 lbs/hr of SO_2 is emitted suggesting an even greater absorption of SO_2 in this mode. Source and sampling data and calculations are given in Appendix A.

TABLE 5 RESULTS OF MM5 IMPINGER CATCH AND PROBE WASH ANALYSES (lbs/hr)

		Impingers				Probe Wash				
Date	Sample ID	$NH_4^=$	Cl^-	F^-	SO_2	NH_4^+	Cl^-	F^-	$SO_4^=$	Mode
6-3	MM5-1	NM(1)	NM	NM	140	5.49	11.63	ND(2)	.03	MOF
6-4	MM5-2	NM	NM	NM	69.9	1.09	2.44	ND	.05	MON
6-5	MM5-3	NM	NM	NM	76.0	2.23	4.91	ND	.03	MON
6-5	MM5-4	1.8	NM	NM	NM	NM	NM	NM	NM	MON
6-6	MM5-5	NM	NM	NM	151	NM	NM	NM	NM	MOF
6-6	MM5-6	3.6	NM	NM	NM	7.72	15.83	ND	NM	MOF
6-11	MM5-7	3.1	NM	NM	NM	6.30	16.51	ND	NM	MOF
6-12	MM5-8	NM	7.4	ND	NM	1.68	3.49	ND	NM	MON
6-12	MM5-9	NM	NM	ND	64.4	1.42	3.11	ND	.05	MON
6-13	MM5-10	NM	24.4	ND	NM	3.34	10.24	ND	NM	MOF
6-13	MM5-11	NM	NM	NM	103	3.48	7.88	ND	.30	MOF
	Averages:				70.1	1.60	3.49	ND	ND	MON
					131.3	5.23	12.42	ND	ND	MOF

(1) NM = not measurred, (2) ND = none detected.

As shown in Table 2, a total of 22 PAGS samples were acquired, 2 pairs of particulate and gaseous Cl^- and F^- in the MON mode and 3 pairs of particulate and gaseous NH_3 in the MON mode. For the MOF mode, 3 pairs and a single run for NH_3 and 2 pairs and a single run for Cl^- and F^- were made. Difficulties with transfer lines and leak checks for 4 of the PAGS samples resulted in questionable results for these runs. The results are flagged in Table 6.

In addition, attempts to vary filter temperatures between the 2 sampling trains on the 4th and 5th study days resulted in probe wash recoveries with inconsistent material for mass and NH_4^+ determination. For this reason the results of PAGSA-C1, PAGSB-C1, PAGSA-C2 and PAGSB-C2 were not included in the calculations for the particulate mass emission rates. Table 6 shows the results of PAGS sampling calculations from the probe wash recoveries. Difficulties with the recovery of the white, insoluble particulate material in the acetone washing were similar to those in the MM5 recoveries. As with the MM5 calculations, the amount of NH_4Cl predicted in each probe wash was calculated by converting the mass of NH_4^+ to an equivalent weight of NH_4Cl.

In calculating the averages for the 2 operating modes, 11 results were used for the MOF mode and only 5 results were used for the MON mode. The results of sample PAGSA-C3 were used for averaging despite technical difficulties during the sampling period. Without this sample, the average emission rate is 25.1 lbs/hr. Finally, the result of PAGS-C6 was not used for MOF mode averaging since the results were not consistent with other MOF samples, especially the simultaneous PAGSA-N6 sample.

TABLE 6. RESULTS OF NH_3 SAMPLING WITH PAGS

Date	ID	Volume (cu ft)	Probe Wash Mass	NH_4^+	Cl^-	Emission[1] Rate	$\%NH_4Cl$	Adjusted[2] Rate	Mode
				(mg)					
6-3	PAGSA-N1	16.707	14.59	0.73	.590	11.61	1.4	11.43	MOF
6-3	PAGSB-N1	19.220	21.63	0.10	.380	14.97	1.4	14.76	MOF
6-4	PAGSA-C1	19.301	1.00	0.03	.290	0.84	NC	NC	MON
6-4*(3)	PAGSB-C1	6.870	ND	0.04	.270	0	NC	NC	MON
6-5	PAGSA-C2	18.353	.56	0.05	.260	.45	NC	NC	MON
6-5*(3)	PAGSB-C2	16.584	4.78	2.10	4.17	4.21	NC	NC	MON
6-5	PAGSA-N2	17.944	14.34	0.54	0.25	11.72	11.2	11.59	MON
6-5	PAGSB-N2	16.713	16.34	.66	1.44	14.32	12.0	12.60	MON
6-6*(3)	PAGSA-C3	16.248	36.40	5.39	15.31	31.89	44.0	17.86	MOF
6-6	PAGSB-C3	15.160	23.58	5.11	11.24	20.72	64.4	7.38	MOF
6-6	PAGSA-N3	15.554	18.72	0.97	2.22	15.94	15.4	13.48	MOF
6-6	PAGSB-N3	14.494	39.14	5.48	12.26	35.77	41.6	20.89	MOF
6-11	PAGSA-N4	15.208	54.25	4.53	11.21	46.66	24.8	35.08	MOF
6-11	PAGSB-N4	14.647	64.41	7.53	19.39	57.69	34.7	37.67	MOF
6-12*(3)	PAGSA-C4		Run Aborted						
6-12	PAGSB-C4	18.514	21.14	3.47	7.49	18.01	48.8	9.22	MON
6-12	PAGSA-N5	20.611	18.71	.534	1.51	14.69	8.4	13.45	MON
6-12	PAGSB-N5	18.805	26.49	1.06	3.59	22.84	11.9	20.12	MON
6-13	PAGSA-C5	16.083	14.71	1.70	4.16	12.59	34.3	8.27	MOF
6-13	PAGSB-C5	14.507	15.34	1.86	4.46	14.08	36.0	9.01	MOF
6-13	PAGSA-N6	16.133	26.13	1.14	3.20	21.39	13.0	18.61	MOF
6-13	PAGSB-C6	14.389	7.81	1.21	2.85	7.22	46.0	3.90	MOF
			Averages			25.8	28.3	17.7	MOF
						16.3	18.4	13.4	MON

(1) Rate in lbs/hr based on probe wash residue weight
(2) Adjusted rate in lbs/hr after subtracting NH_4Cl
(3) Technical difficulties with sampling and/or recovery

TABLE 7. RESULTS OF PAGS IMPINGER CATCHES (lbs/hr)

Date	Sample I.D.	NH_4^+	Cl^-	F^-	Probe Temp (°F)	Mode
6-3	PAGSA-N1	2.4			480	MOF
"	PAGSB-N1	6.7			480	MOF
6-4	PAGSA-C1		7.2	ND	360	MON
"	PAGSB-C1		6.7	ND	360	MON
6-5	PAGSA-C2		6.3	.01	360	MON
"	PAGSB-C2		2.8	ND	250	MON
6-5	PAGSA-N2	1.3			360	MON
"	PAGSB-N2	2.5			360	MON
6-6	PAGSA-C3		ND	ND	360	MOF
"	PAGSB-C3		12.8	ND	250	MOF
6-6	PAGSA-N3	.01			360	MOF
"	PAGSB-N3	.07			250	MOF
6-11	PAGSA-N4	.14			360	MOF
"	PAGSB-N4	1.73			250	MOF
6-12	PAGSA-C4			aborted	360	MON
"	PAGSB-C4		9.1	ND	250	MON
6-12	PAGSA-N5	.07			360	MON
"	PAGSB-N5	.33			250	MON
6-13	PAGSA-C5		5.1	.02	360	MOF
"	PAGSB-C5		9.8	ND	250	MOF
6-13	PAGSA-N6	.01			250	MOF
"	PAGSB-C6		14.4	ND	250	MOF

The results of the PAGS sampling systems impinger catches and analyses are shown in Table 7. Similar to the MM5 results, insufficient amounts of NH_4Cl were in the gas phase during both operating modes to establish a trend. The data do indicate that as much as 98 percent of the NH_3 can pass the probe and filter, as in sample PAGSB-N1 or as little as 1.3 percent as in sample PAGSB-N3. Since both of these samples involve MOF modes, the gas-particulate phase distribution of NH_4Cl appears to be highly variable for this mode.

For samples PAGSA-N2 and PAGSB-N2, both acquired at the same time during MON mode, 74.5 and 81.6 percent respectively of the total NH_4^+ was collected in the impingers. Both samples were obtained with a 360° probe temperatures indicating that control of NH_4Cl within the baghouse may involve temperatures below 360°F. Source and sampling data and calculations are shown in appendix B.

A summary of the 2 methods used for measuring particulate mass emissions are shown in Table 8. The MM5 calculations include probe wash weights and probe wash weights less the NH_4Cl calculated from the NH^+_4 analysis. For the PAGS systems, 3 types of results are presented. Along with the regular probe wash, probe wash mass less the calculated NH_4Cl mass emission rates are given. In addition, a total emission rate which includes the filter and the impinger catch of either NH_4^+ or Cl^- according to the method is presented.

Filter weights and analyses of the PAGS samples were found to be insignificant relative to the probe wash mass and impinger catches and are not presented. Most of the PAGS filters were reweighed and found to have lost weight. Analyses of the filters showed virtually no NH_4^+ or Cl^-.

TABLE 8 PARTICULATE EMISSION RATES USING VARIOUS CALCULATIONS (lbs/hr)

Date	MM5(1)	MM5-N(2)	PAGS-A(1)	PAGS-A(3)	PAGS-A(4)	PAGS-B(1)	PAGS-B(3)	PAGS-B(4)
6-3	32.8	14.4	11.6	19.1	11.4	15.0	36.0	14.8
6-4	16.4	12.3	0.8	11.7	0.5	0	10.1	-
6-5	21.4	13.5	0.4	9.9	0.2	4.2	8.4	-
6-5	SL(5)	SL	11.7	15.8	11.6	14.3	22.2	12.0
6-6	SL	SL	31.9	31.9	17.9	20.7	40.0	7.4
6-6	38.3	12.6	15.9	15.9	13.4	35.8	36.0	20.9
6-11	43.7	23.2	46.7	47.1	35.1	57.7	63.1	37.7
6-12	16.7	10.4	SL	SL	SL	18.0	33.7	9.2
6-12	18.3	13.2	14.7	14.9	13.4	22.8	23.2	20.1
6-13	30.3	18.9	12.6	20.3	8.3	14.1	28.9	9.0
6-13	15.9	2.7	21.4	21.4	18.6	7.2	28.9	3.9

(1) Calculated from conventional filter and probe wash weights.

(2) Calculated from MM5 particulate less NH_3 and HCl weights.

(3) Calculated from probe, filter, and NH_3 and HCl impingers.

(4) Calculated from probe and filter catch less the NH_3 and HCl.

(5) Sample loss due to analytical or sampling error.

Since the collection and recovery of NH_4Cl for both methods used varied widely amoung corresponding samples, Table 9 below shows the emission rates less NH_4Cl.

TABLE 9 SUMMARY OF ADJUSTED EMISSION RATES (lbs/hr)

Date	MM5	PAGSA	PAGSB	Mode
6-3	14.4	11.4	14.8	MOF
6-4	12.3	NC	NC	MON
6-5	13.5	NC	NC	MON
6-5	NC	11.6	12.0	MON
6-6	NC	17.9	7.4	MOF
6-6	12.6	13.4	20.9	MOF
6-11	23.2	35.1	37.7	MOF
6-12	10.4	NC	9.2	MON
6-12	13.2	13.4	20.1	MON
6-13	18.9	8.3	9.0	MOF
6-13	2.7	2.7	18.6	MOF
Averages	17.5(4)	17.4(6)	18.0(5)	MOF
	12.4(4)	12.5(2)	13.8(3)	MON

As the Table 9 averages indicates, average particulate emissions rates are similar when the unpredictable distribution of NH_4Cl is disregarded.

A total of 14 particle sizing samples were acquired during the sampling period with the impactors. During the first 3 days the impactor was located in the sample stream and was at stack temperature. Recovery of the greased plates from the first sample indicated that high temperatures necessitated the use of quartz and uncoated steel plates during subsequent samples. Several of the quartz impactor plates were not weighed but submerged into separate aliquots of 0.1N H_2SO_4 upon recovery. The impactor sampling parameters are shown in Tables 10 and 11. Two samples, one for each operational mode were

weighed after collection recovery and then submerged in the dilute H_2SO_4.

As the data in Table 11 show, the mass emission rate of particulate matter is considerably less for the highest impactor run than the amount calculated from the MM5 and PAGS samples. Given the excessive impact NH_4Cl showed on the particulate methods, the erratic results obtained with the impactor runs are not surprising. With the impactor located within the stack, gas phase NH_3 and HCl would pass through the impactor and the backup filter. For extractive sampling, with the impactor located outside the stack in the heated box, NH_4Cl likely formed and deposited in the transfer line prior to the impactor.

Some indication of this is shown in Table 12. Samples P-4 and P-7 were both weighed and analyzed for NH_4^+. Sample P-4 was acquired during the MON made at 350°F in the stack. The backup filter for P-4 was not weighed prior to NH_4^+ analysis. For this impactor run, stages 1, 2, and 3 the larger particle contained most of the particulate mass with very little NH_4^+. Similar results were obtained for P-7, sampled in the stack during the MOF mode. While the mass of stage 3 of this run was approximately 10% NH_4^+, this amount contributed little to the calculated total mass emission rate from this impactor run. Source and sampling data and calculations for the impactor samples are shown in Appendix C.

TABLE 10. SCHEDULE OF PILAT SAMPLES COLLECTED

Date	ID	Time	Mill Mode	Type(1)	Temperature(2)	Recovery(3)
6-4	P-1	3:30pm	MON	H	340	G
6-5	P-2	11:30am	MON	Q	334	A
6-5	P-3	3:55pm	MON	Q	350	A
6-5	P-4	7:00pm	MON	Q	350	G&A
6-6	P-5	10:47am	MOF	Q	486	A
6-6	P-6	2:00pm	MOF	Q	486	A
6-6	P-7	5:07pm	MOF	Q	488	G&A
6-11	P-8	12:15pm	MOF	S	478	G
6-11	P-9	3:05pm	MOF	Q	250	A
6-12	P-10	10:00am	MON	H	250	G
6-12	P-11	12:30pm	MON	Q	250	A
6-12	P-12	3:15pm	MON	S	250	G
6-13	P-13	9:30am	MOF	S	250	G
6-13	P-14	11:25am	MOF	S	250	G

(1) H = Apezion Grease, Q = Quartz, & S = Steel
(2) Temperature of Pilat in °F, either instack or in heated box at 250°F
(3) Recovery by; A = Ammonium ion analysis and/or G = gravimetric analysis.

TABLE 11 SUMMARY OF PILAT SAMPLING PARAMETERS AND ANALYSIS RESULTS

ID	Pilat Location	Type	Mode	lbs/hr(2)	F(3)	T(4)
P-1G	In Stack	H-Grease	MON	3.93	95.6%	337
P-10G	Box	H-Grease	MON	2.53	86.9%	250
P-8G	Box	S.Steel	MOF	.18	0.0	250
P-12G	"	"	MON	2.57	85.6	250
P-13G	"	"	MOF	3.56	64.3	250
P-14G	"	"	MOF	1.02	71.8	250
P-4G	In Stack	Quartz	MON	1.97	0%	349
P-4A	"	"	MON	.08	30.1%	349
P-7G	In Stack	Quartz	MOF	4.30	0	488
P-7A	"	"	MOF	.06	8.9%	488
P-2A	In Stack	Quartz	MON	.09	10%	334
P-3G	"	"	MON	.01	40%	334
P-5A	"	"	MOF	.12	15.1%	486
P-6A	"	"	MOF	.09	11.5%	486
P-9A	In Box	"	MOF	.14	1.6%	250
P-11A	"	"	MON	.07	17.0%	250

(1) A = Ammonium, G = Gravimetric
(2) Represents emission rate of Ammonium or particulate mass collected by all stages and backup filter.
(3) Represents amount of total Pilat catch on backup filter.
(4) Represents temperature in Fahrenheit the Pilat was maintained at during sampling.

TABLE 12. RESULTS OF GRAVIMETRIC AND CHEMICAL ANALYSIS OF PILATS

ID	Sample Analysis	Stage# 1	2	3	4	5	6	7	F	lbs/h
P-4	Mass(g)	441	581	612	-190	99	-38	-2014	NM(1)	1.97
P-4	NH_4^+(g)	11	6	10	1	8	4	11	22	.08
P-7	Mass(g)	354	211	628	892	478	510	713	-288	4.30
P-7	NH_4^+(g)	10	7	65	11	4.5	6.0	5.0	5	.06
P-1	Mass(g)	68	59	0	0	20	0	3	3280	3.93
P-2	Mass(g)	6	4	14	13	9	14	12	8	.09
P-3	Mass(g)	0	0	1	0	0		0	4	.01
P-5	NH_4^+(g)	11	8	12	17	13	16	13	16	.12
P-6	NH_4^+(g)	19	8	13	1	6	8	14	9	.09
P-9	NH_4^+(g)	46	16	18	5	11	14	10	2	.14
P-10	Mass(g)	114	92	52	55	55	0	156	3484	2.53
P-11	NH_4^+(g)	17	19	15	10	12	8	12	19	.07
P-12	Mass(g)	281	113	23	37	51	36	35	3.423	2.57
P-13	Mass(g)	122	1.6	31	42	45	46	52	3.500	3.56
P-14	Mass(g)	143	64	42	60	37	32	66	1132	1.02

(1) Not measured

A considerable number of characterization filters for both operating modes, with glass, quartz and Teflon filter were collected. Such filters would routinely be submitted for X-Ray flourescence (XRF) analysis and electron microscopy when collected from most sources. However, since much of the particulate matter from the MM5 and PAGS methods were confirmed to be NH_4Cl and since it is not detected by XRF, only a small number of the filters were analyzed by XRF. The NH_4^+, Cl^- and F^- results of a limited number of characterization filter analysis are shown in Table 13.

TABLE 13 RESULTS OF CHARACTERIZATION FILTERS ANALYSIS

MODE	Filter Type	NH_4^+	Cl^-	F^-
		(μg)		
MON	GF	ND*	1406	ND
MON	GF	2.0	1346	ND
MON	TE-37	ND	ND	ND
MON	TE-37	ND	ND	ND
MOF	GF	ND	1611	14.3
MOF	GF	2.0	1531	14.4
MOF	TE-37	ND	ND	ND
MOF	TE-37	ND	ND	ND

*ND not detected

With the exception of the glass fiber filters, no appreciable mass could be verified on the filter by analysis. On the glass filters, the presence of Cl^- is likely due to absorption of gaseous HCl, which is not absorbed by the Teflon filters[7]. Since the characterization filter samples were collected

in the heated box external to the stack, the NH_4Cl was likely retained in the transfer probe prior to the filter holders similar to the extractive impactor samples.

Despite the very limited information provided by the characterization filters and impactor data, the absence of significant particulate matter serves to reinforce the conclusions drawn from the extractive particulate methods. Those sample results indicate little difference in particulate emission rates between the MON and the MOF modes. The significant differences are in the NH_4Cl of the particulate measurements in the sampling systems. Difficulties in recovering the probe washes were encountered and likely impacted on the results, since the probe washes contained most of the collected particulate matter.

These results indicate that the formation of particulate NH_4Cl at temperatures lower than the instack gas temperatures are likely to cause the formation of a detached opaque plume. Assuming this NH_4Cl formation as the stack gases cool is the cause of the detached opaque plume, the sources of gaseous NH_3 and the means to reduce or eliminate it were sought.

The presence of the gas phase NH_3 and HCl causes considerable difficulties in particulate sampling and sample recovery. In both the MM5 sampling train and the prototype PAGS trains, difficulties in removing and transferring the white precipitate present in the probes with an acetone wash were encountered. In the earlier part of the sampling program a routine QA/QC procedure of a double recovery was performed. This procedure involved the breakdown and recovery of a sample according to the prescribed procedure, followed by the same recovery procedure a second time. This double recovery addresses both mass and chemical recovery efficiencies. For the MM5-6 probe wash, the initial recovery resulted

in a mass of 59.75mg. Included in the mass, according to chemical analysis was 13.47mg of NH_4^+ and 27.61 mg of Cl^- which represents 68.8 percent of the total mass recovered from the probe. During the second recovery 26.17 mg of additional mass was recovered, and contained 0.53mg of NH_4^+ and 1.41 mg of Cl^-. This is a nominal 7.4 percent. For the MM5 recovery efficiencies, the 59.75mg of the first recovery is 69.5 percent of the total mass recovered by both attempts, while the 13.47 and 27.61 mg of NH_4^+ and Cl^- was 96.2 and 95.1 percent efficient respectively.

For the PAGS systems, double recoveries were performed on samples PAGSA-N3 and PAGSB-N3. For the AN3 sample 18.72 mg of mass was recovered during the first wash and 20.71 mg of mass during the second. For the first recovery 0.97mg of NH_4^+ and 2.22 mg Cl^- were collected, while 1.17mg of NH_4^+ and 2.66mg Cl^- were collected during the second wash. This represents recovery efficiencies of 47.5, 45.3 and 45.5 percent for mass, NH_4^+ and Cl^- respectively. For the B-N3 sample, the initial recovery showed 39.14, 5.48, and 12.26 mg of mass, NH_4^+ and Cl^- respectively. The second recovery collected 34.45, 4.56, and 9.31mg of mass, NH_4^+ and C^- respectively. The average recovery efficiencies for both PAGS systems are 50.3, 49.9, and 51.1 percent for mass, NH_4^+ and Cl^- respectively.

RESULTS OF PROCESS SAMPLING

As discussed previously in the emissions sampling program, extensive process samples were collected during the test period. Samples of solid materials beginning with the limestone and shale through to the baghouse catches were collected. Fig. 3 indicates the sampling points from which the solids and some gases were collected.

Since the results from the probe wash analyses suggest that the formation of a visible plume was likely the result of particulate NH_4Cl formation, NH_3 analyses of solid process samples were conducted. Initially the analysis scheme involved weighing a solid sample and then adding it to a 0.1N H_2SO_4 solution. After thorough mixing, the solution was filtered and the residue washed. The washings were combined for NH_4^+ analyses.

A limited number of gaseous NH_3 and HCl samples were acquired at sampling points I, E, and F, the alkali bypass stack and the bottom of the first and second cyclones in the heat exchanger, respectively. The results of the 10 samples are shown in Table 14.

Little free NH_3 or HCl was found in the the gaseous NH_3 and HCl samples taken at site E. The temperature at this sampling site is nominal 750°F. No NH_3 was formed either from the kiln, or raw feed point D. Only one NH_3 sample was taken at site F, where the temperature is nominal 1130°F. At this site gaseous NH_3 was collected and determined to be 6.2 mg NH_4^+/m^3. These suggests an apparent release of NH_3 during the heating from 750 to 1130°F in the heat exchanger.

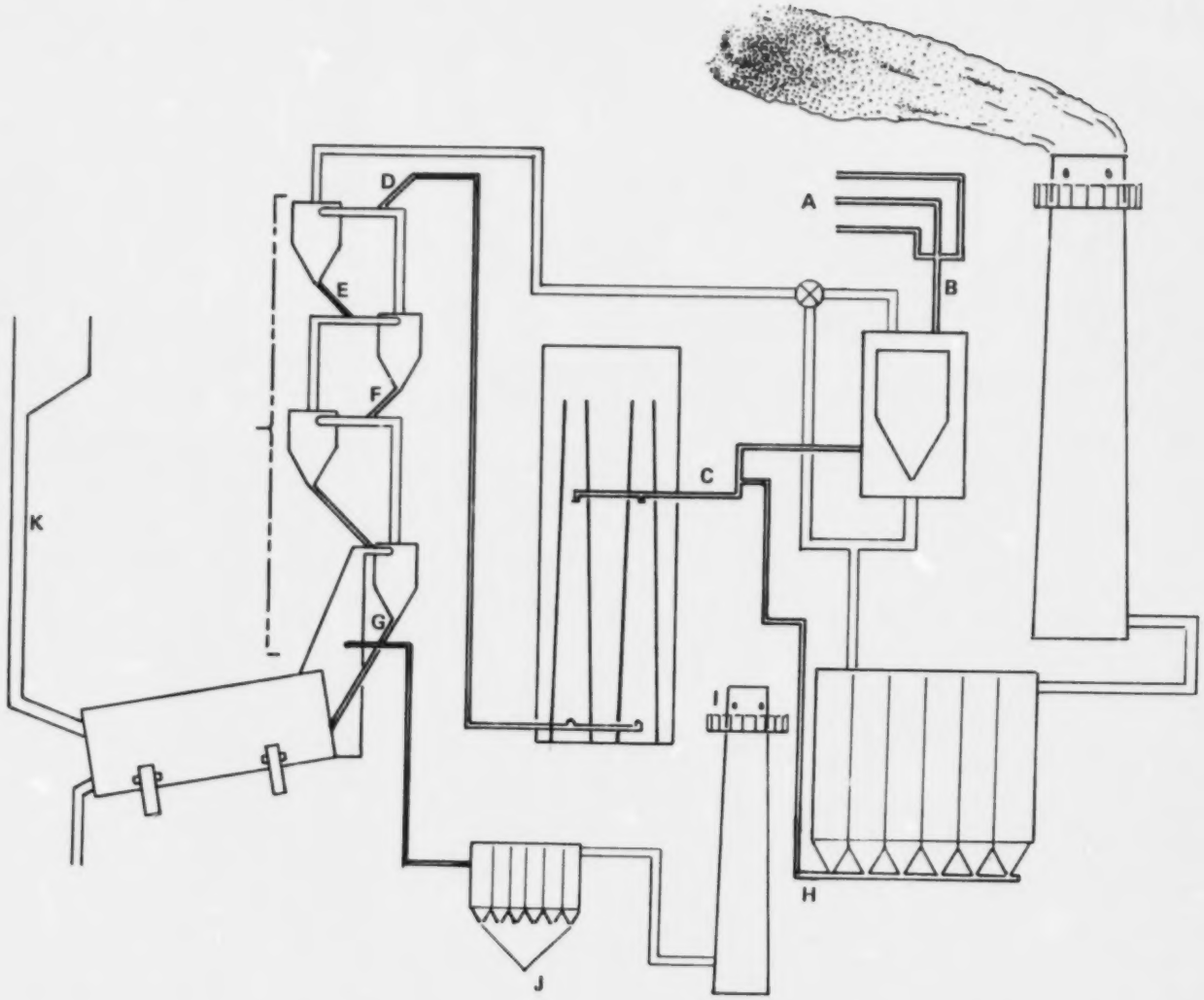


FIGURE 3. COLLECTION POINTS OF NON-SOURCE SAMPLING

TABLE 14. RESULTS OF GASEOUS PROCESS SAMPLES

Sampling Site[1]	Date	Sample[2] Volume	NH_4^+ (μg)	mg NH_4^+/m^3
I	6-12	.0313	68.8	2.2
I	6-13	.0461	37.8	0.8
I	6-13	.0419	46.0	1.1
F	6-5	.0116	68.0	6.2
E	6-5	.0260	12.0	0.4
E	6-6	.0374	24.0	0.6
E	6-6	.0284	13.0	0.4
			gCl	mg Cl^-/m^3
E	6-12	.0268	33.2	1.2
E	6-12	.0171	2.4	0.1
E	6-13	.0187	-none detected-	

(1) According to Figure 3.
(2) Cubic meters at Std. conditions

TABLE 15 RESULTS OF LOESCH MILL NH_4^+ ANALYSIS

Date	Sample	Time	Wt.(1)	NH_4^+(μg)	μgNH_4^+/g	Avg.
6/5	LM	10	8.3	228	27.4	
	LM	11	8.0	259	32.3	
	LM	12	9.8	407	41.5	
	LM	1	9.6	441	45.9	
	LM	2	13.7	341	24.9	34.4
6/7	LM	7	7.7	327	42.4	
	LM	8	9.4	352	37.4	
	LM	9	8.0	352	44.0	
	LM	10	7.9	338	42.8	
	LM	11	12.6	404	32.1	
	LM	12	11.1	328	29.5	
	LM	1	10.0	417	41.7	
	LM	2	6.7	329	49.1	39.9
6/12	LM	12	10.9	304	27.9	
	LM	1	16.6	396	23.9	25.9
				Average	33.4 (15)	

(1) wt in g

TABLE 16 RESULTS OF HEAT EXCHANGER FEED NH_4^+ ANALYSIS

Date	Sample	Time	Wt.(1)	NH_4^+(μg)	μgNH_4^+/g	Avg.	Mode
6/5	KF	11AM	11.1	449	40.4		
	KF	1PM	12.4	382	30.8	35.6	MON
6/6	KF	7AM	8.9	324	36.4		MOF
	KF	9AM	9.7	404	41.6		
	KF	11AM	7.4	399	53.9		
	KF	1PM	6.2	338	54.5	46.6	
6/7	KF	7AM	9.3	434	46.7		MON
	KF	9AM	7.4	280	37.8		
	KF	11AM	6.7	239	35.7		
	KF	12PM	10.1	425	42.1	40.6	
6/11	KF	11AM	18.0	513	27.1		MOF
	KF	1PM	18.9	552	29.2	28.1	MOF
6/12	KF	1PM	10.8	468	43.3		MON
6/13	KF	7AM	15.1	563	37.3		MOF
	KF	9AM	18.6	636	34.2		MOF
	KF	1AM	15.7	636	40.5	37.3	MOF

Avg. KF - MON 39.8 (7)
Avg. KF - MOF 37.3 (9)

(1) Wt in g

Gaseous NH_3 sampling was conducted at site I to investigate the possible formation of NH_3 within the kiln. The alkali bypass (point J) function is to extract alkali material at high temperature in order to maintain a high quality product. Sampling at this bypass is the best location to sample the kiln gases directly before they pass through the raw feed. As Table 14 indicates, very little gaseous NH_3 is present at this sampling point.

Averaging the results of the NH_4^+ found in the MM5 probe washes and assuming the NH_4^+ was in the gaseous state prior to its collection in the probe, the results predict 16.0 mgNH_4^+/m^3 and 4.4 mgNH_4^+/m^3 for the MOF and MON modes respectively. These results indicate the presence of gaseous NH_3 in the stack emissions which are not present in the kiln exhaust.

Solid process samples were collected at the baghouse (site H), heat exchanger, (sites E, F, G), raw products derived to the silos (site C) and heat exchanger feed (site D). At sites C and D hourly samples were taken during each operational mode. The presence of NH_4^+ in these samples, as determined by washing the solids with 0.1N H_2SO_4 is shown in Tables 15 and 16. The average $\mu g\ NH_4^+/g$ for all 15 samples from the Loesch mill is 36.2 $\pm$7.4. For the 16 samples from the kiln feed the average $\mu g\ NH_4^+/g$ is 39.4 $\pm$5.9. No significant differences in NH_4^+ content of kiln and Loesch mill solids were found based on the analysis. In addition no relationship between the NH_4^+ content and sample acquisition time is evident.

TABLE 17 RESULTS OF HEAT EXCHANGER SOLIDS NH_4^+ ANALYSIS

Date	Site	wt(g)	Temp(°F)	NH_4^+(μg)	μgNH_4^+/g	Mode
6/5	E	8.1	730	287	35.4	MON
6/5	F	11.7	1130	196	16.8	MON
6/6	E	12.9	642	480	37.2	MOF
6/6	F	14.1	1120	168	11.9	MOF
6/11	E	9.0	711	479	53.2	MOF
6/11	F	7.8	1108	157	20.1	MOF
6/12	E	7.8	728	361	46.3	MON
6/12	F	8.6	1127	170	19.8	MON
6/12	E	8.0	720	347	43.3	MON
6/12	F	5.3	1140	151	28.4	MON
6/13	E	13.2	715	416	31.5	MOF
6/13	F	7.5	1040	161	21.4	MOF
6/12	G	9.7	1500	None	Detected	MON
6/12	G	9.6	1500	"	"	MON

Stg 1 Avg - 41.2	
Stg 2 Avg - 19.7	
Stg 1 Avg - 41.7	MON
Stg 1 Avg - 40.6	MOF
Stg 2 Avg - 21.7	MON
Stg 2 Avg - 17.8	MOF

TABLE 18 RESULTS OF BAGHOUSE SOLIDS NH_4^+ ANALYSIS

Date	Wt(g)	Temp(°F)	NH_4^+(μg)	μg NH_4^+/g	Avg.	Mode
6/5	5.7	342	763	133.8		MON
6/5	5.0	342	725	145.0		MON
6/5	4.9	342	778	158.8		MON
6/5	6.4	342	663	103.6		MON
					135.3	
6/6	8.5	486	600	70.6		MOF
6/6	5.7	486	524	91.9		MOF
6/6	6.2	486	451	72.7		MOF
6/6	6.3	486	493	78.3		MOF
					78.4	
6/11	6.0	480	313	52.2		MOF
6/12	6.5	335	667	102.6		MON

MON Avg. 128.8
MOF Avg. 73.2

Samples of the kiln feed as it passed down through the heat exchanger to the kiln were collected at sites E, F, and G. The results of NH_4^+ analysis with the 0.1N H_2SO_4 washing technique are shown in Table 17. There is an apparent drop in NH_4^+ content as the solids pass from stages 1 to stage 2, where a temperature change of about 400°F occurs. This is consistent with the one gaseous NH_3 sample taken at site F, with 6.2 mg NH_4^+/m^3. The site E gaseous samples indicated little gaseous NH_3 at Stage 1. In general stage 2 had only about 50% of the NH_4^+ that stage 1 had. This difference was little affected by the operational mode.

The results of NH_4^+ analysis of solids collected at the baghouse recycled material (Site 5) are given in Table 18. The samples of this material taken during the MOF mode had much less NH_4^+ than those taken during the MON mode. About 42% of the 135.3 g NH_4^+ present in the MON mode is apparently in the gas phase during the MOF mode. These data are consistent with the MM5 probe wash data which indicate that nearly 16.0 mg NH_4^+/m^3 is as gas phase in the MOF mode while only 4.4 mg NH_4^+/m^3 in the MON mode. The effect of baghouse temperature, which is a nominal 140°F higher in the MOF mode, is a likely explanation for the differences in the data.

Samples were collected from raw feed stocks at site locations A and B. Since some plant personnel suggested a possible source of NH_3 in the cement production might be the residual blasting ammonium nitrates, four samples were taken from the mine soon after a blast. Samples were also taken from the raw shale and raw feed belt to the Loesch Mill at site B. The results of the analysis of the 0.1N H_2SO_4 washes of these samples are shown in Table 19.

TABLE 19 RESULTS OF RAW FEED NH_4^+ ANALYSIS

Sample Type	Sample Wt(g)	NH_4^+(μg)	μg NH_4^+/g
Mine ore	131	72.0	0.54
"	134	89.0	0.66
"	144	23.0	0.16
"	124	21.1	0.17
Shale	10.4	76.0	7.31
"	17.8	83.1	4.67
"	14.2	75.0	5.28
"	12.9	96.0	7.44
Raw Feed	24.2	56.0	2.31
"	25.3	49.1	1.94
"	24.4	49.0	2.01
"	27.4	50.1	1.83

The data in Table 19, acquired from the acid washing of the solids, indicate that the raw material used in the process was generating the NH_3. One explanation offered was that organic and other nitrogen compounds in the shale could decompose into gaseous NH_3. A study to determine if the shale organic compounds were the major source of the NH_3 was undertaken.

The study involved constructing a metal container into which a preweighed sample could be placed, and then subsequently placed into a muffle furnace for controlled heating. On the exit tube of the metal container an impinger system containing 0.1N H_2SO_4 was attached such that components liberated from the shale during heating could be collected. On the inlet of the system a bubbler containing of 0.1N H_2SO_4 was attached to prevent atmospheric NH_3 from being drawn in and interfering with the study.

The results of 2 series of runs with this system are shown in Tables 20 and 21. The runs from which the data are given in Table 20, a temperature between 1200 to 1250°F was maintained while varying the heating times. These data show that a large amount of free NH_3 can be liberated from the shale on heating. They also show that the potential NH_3 content can vary from 36.7 to 125.9 g/g. The data also show that the NH_3 can be released as efficiently in 1 hour as 3 hours at 1200°F. The average for all 8 samples is 60.7 g/g of NH_4^+ or 51.4 μg/g when the 125.9 result is not included.

TABLE 20 RESULTS OF SHALE - NH_4^+ TEMPERATURE STUDIES

Sample wt (mg)	Temp (°F)	Heating Time	NH_4^+ (μg)	$\frac{\mu g\ NH_4^+}{g\ Sample}$	Total
63.6	1250	3:17	2997	47.1	
63.6	1250	2:00	0	0	47.1
67.8	1240	2:48	2956	43.6	
67.8	1238	3:27	12	0.2	43.8
73.1	1218	3:43	2860	39.1	
73.1	1211	3:28	15	.2	39.3
69.8	1242	3:12	3662	52.4	
69.8	1212	3:18	5	.1	52.5
65.5	1212	2:05	2362	36.1	
65.5	1212	:58	37	.6	36.7
67.8	1200	2.08	8532	125.8	
67.8	1209	:58	10	.1	125.9
64.3	1211	1:00	3242	50.4	
64.3	1213	1:46	40	.6	51.0
64.3	1233	1:27	5782	89.4	
64.3	1219	2:00	11	.2	89.6

The data in Table 21 were acquired by heating shale samples to between 1100 and 900°F for various time intervals. The data show that both temperature ranges are adequate to release the NH_3. Virtually all of the NH_3 was released when heated for 75 min at 950°F. Since this temperature is comparable to the 1st to 2nd stages of the heat exchanger, a reasonable mechanism is that NH_3 is being liberated from the shale in the heat exchanger.

TABLE 21 RESULTS OF SHALE - NH_4^+ TEMPERATURE STUDIES

Sample wt (mg)	Temp (°F)	Heating Time (hr:min)	NH_4^+ (μg)	$\frac{\mu g\ NH_4^+}{mg\ Sample}$	Total
64.7	1090	2:55	5782	89.4	
64.7	1082	2:53	11	.2	89.6
64.4	1120	1:00	4402	68.4	
64.4	1090	2:53	117	1.8	70.2
62.4	1100	2:11	6122	98.1	
62.4	1100	2:50	32	.5	98.6
67.8	916	2:52	2967	43.8	
67.8	892	3:20	41	0.6	44.4
63.7	950	1:15	2742	43.0	
63.7	920	2:53	168	2.6	45.6
64.1	910	1:59	2172	33.9	
64.1	905	2:36	84	1.3	35.2

Discussions of Sampling Problems

One of the basic objectives of the study was to identify the cause of the plume formation. For this reason it was adequate to find a representative sampling point from the traverses for particulate sampling. For traversing this source during actual compliance sampling, the effect from variations in the probe temperatures when sampling from the nearest to the fartherest point from the port would be unpredictable. In addition, the longer the probe the more difficult on efficient mass recovery would be.

The effect the formation and recovery of NH_4Cl in the probe washes of both types of sampling systems poses questions of how accurately compliance testing for particulate matter can be performed for this type of source.

An additional problem of sampling at these types of plants is the ever present and variable fugitive type dust in the environment. Daily aliquots of acetone were taken as blanks from the same bottle as used for probe washing. From 5 separate acetone blanks an average of 6.84 to 1.39 g of mass was recovered upon evaporating the acetone in the laboratory. Similar acetone blanks acquired from the same reagent source under laboratory conditions showed little residual mass. For the 9 MM5 samples, an average of 41.35mg of material was collected in the probe washes. Compared to this, 6.84mg blank represents 16.5 percent of the average recovery. Therefore, particulate sampling and recovery on-site requires an extremely high degree of precaution to avoid such interferences.

CONCLUSIONS

The thorough sampling and analysis program completed during this study has suggested that the detached visable plume is due to particulate NH_4Cl formed in the plume. The study also gives results that indicate the source of gaseous NH_3 in cement kiln emissions is the bound nitrogen, likely organic in nature, liberated from the shale portion of the raw feed products when heated in the cement manufacturing process. Similar to the Leeds plant results obtained in an earlier study, the NH_3 reacts with gaseous HCl as the emission gases cool after exiting the stack. Partial collection of the NH_3 and HCl as NH_4Cl occurs in the baghouse control device at the lower temperature MON mode. This collected NH_4Cl however is fed back into the blend silos with the raw feed. Eventually this NH_4Cl along with newly formed NH_3 and HCl are returned to the baghouse. Since sufficient amounts of NH_3 and HCl are present in the gas stream that penetrate the baghouse, a less opaque and non-persistent visible plume occurs in the MON mode.

Analysis of in-process samples for NH_3 has shown that little NH_3 is derived from either the limestone or the coal fired kiln. Limestone samples heated to 1200°F for 3 hours show little NH_3 evolution. Samples from the alkali bypass which extracts a fraction of the kiln gases showed little NH_3, and eliminated the kiln as a significant source of NH_3 formation. This study showed that heating the shale resulted in the evolution of gaseous NH_3. The method analyses used distinguishes NH_3 from nitrates and other nitrogen compounds. The study also showed that heating the shale to a nominal 900°F for 1 hr will liberate the NH_3. These results suggest that

this same NH_3 liberating process occurs in the lower temperatures sections of the heat exchanger and is the source of the NH_3 emissions. For a raw feed rate of 224,000 lbs/hr which is 12% shale, the shale feed rate to the kiln is 26,880 lbs/hr. Using an average NH_4^+ content of 51.4ppm for the shale, this is equivalent to 1.4 lbs/hr feed rate for NH_4^+. If all of this were emitted from the stack as NH_4Cl it would amount to 4.1 lbs/hr. When the plant was operated in the bypass mode, the baghouse temperature was 486°F and collected solids that contained 128.8 μg NH_4^+/g solids. These data indicate that the NH_3 in the stack emissions increased by about 75% in the bypass mode.

While the purpose of this study was to identify the cause of the detached visible plume formation, the results can lead to some suggestions of control strategies to reduce the problem. Since the shale is the potential sources of the ammonia and it is liberated during heating, preheating the shale before the Loesch Mill raw feed would reduce or eliminate the problem. Lowering the temperature of the baghouse would initially result in lower NH_3 emissions however, since the baghouse catch is recycled through the silos to the kiln feed a build up of NH_4Cl would occur. A practical approach to reducing the NH_3 emissions would be to lower the temperature of the baghouse and use its recycle feed for the wet process systems which do not have a major visible detached plume problem.

REFERENCES

1. "Estimation of the Importance of Condensable Particulate Matter to Inhalable Particulate," Task Report No. 37, EPA Contract 68-02-3512, Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, Nov. 1982.

2. Dellinger, B., Grotecloss, G., Fortune, C.R., Cheney, J.L., and Homolya, J.B., "Sulfur Dioxide Oxidation and Plume Formation at Cement Kilns," Eviron. Sci. & Technol., 14 (10): 1244, 1980.

3. Cheney, J.L., Conner, W.D., Bennett, R.L., et al "Formation of a Detached Plume From a Cement Plant," EPA-600/3-83-102, US Environmental Protection Agency, Research Triangle Park, NC, Dec. 1982.

4. Gartner, E., and Wilk, C.M., "Nitrogen Oxide Emissions from Raw Materials in Cement Kilns," Presented at the 77th Annual Meeting of the Air Pollution Control Association, San Francisco, CA, Paper No. 84-448, June 24-29, 1984.

5. Griffin, R.D., Quartucy, G.C., and Sheth, S. "Interferences of SO_2 and reduced Nitrogen Compounds in Particulte Sampling of Cement Kiln (Precalciners) Stacks, "Presented at the 78th annual meeting of the Air Pollution Control Association, Detroit, MI, Paper No. 85-61.1, June 16-21, 1985.

6. Cheney, J.L., "Minature Acid Condensation System Design and Operation", EPA-600/3-84-056, US Environmental Protection Agency Research Triangle Park, NC 27711, April 1984.

7. Cheney, J.L., and Duke, D.L., "Effects of Gaseous Hydrochloric Acid on Source Particulate Characterization," Anal. Lett, 16 (A4), 309-316 (1983).

APPENDIX A

MODIFIED METHOD FIVE CALCULATIONS

Method 5 data reduction

(datafile=sd_meth5)

Plant	South Dakota Cement
Run Number	M/5-01
Date of Run	03-June-1985
Operator	Chip Duke
Sampling Location	Stack #4 / Port A
Filter Type	Glass Fiber
Meter Box Identification	2102
Delta H@ (inches H2O)	2.23
Meter Correction Factor (dimensionless)	0.970
Start Time	16:59
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	60
Barometer (inches Hg)	26.56
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.53
Volume of Gas Sampled at Meter Conditions (ft3)	25.019
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	70.4
Average Stack Temperature (degrees Fahrenheit)	487.6
Nozzle Inside Diameter (inches)	0.1875
Relative Stack Static Pressure (inches H2O)	-0.40
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.0
H2O Collected (ml)	42.7
Moisture in Stack Gas (percent by volume)	8.6
Isokinetic Rate (percent)	104.4
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	53.010
Total Mass Collected (mg.)	53.010
Gas Sampling Rate at Stack Conditions (ft3/min)	0.792
Volume of Gas Sampled at Normal Conditions (ft3)	21.477
Volume of Gas Sampled at Normal Conditions (m3)	0.608
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6576049
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	186213
Mass Emission Rate at Standard Conditions (lb/hr)	32.79
Mass Emission Rate at Standard Conditions (kg/hr)	16.23

Method 5 data reduction

(datafile=sd_meth5)

Plant	South Dakota Cement
Run Number	M/5-02
Date of Run	04-June-1985
Operator	Chip Duke
Sampling Location	Stack #4 / Port A
Filter Type	Glass Fiber
Meter Box Identification	2102
Delta H@ (inches H2O)	2.23
Meter Correction Factor (dimensionless)	0.970
Start Time	13:31
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	n/a
Barometer (inches Hg)	26.61
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.920
Delta H (inches H2O)	0.78
Volume of Gas Sampled at Meter Conditions (ft3)	30.511
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Fahrenheit)	69.1
Average Stack Temperature (degrees Fahrenheit)	336.6
Nozzle Inside Diameter (inches)	0.1875
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	68.2
H2O Collected (ml)	70.3
Moisture in Stack Gas (percent by volume)	11.2
Isokinetic Rate (percent)	106.9
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	27.180
Total Mass Collected (mg.)	27.180
Gas Sampling Rate at Stack Conditions (ft3/min)	0.839
Volume of Gas Sampled at Normal Conditions (ft3)	26.323
Volume of Gas Sampled at Normal Conditions (m3)	0.745
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7869269
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	222833
Mass Emission Rate at Standard Conditions (lb/hr)	16.42
Mass Emission Rate at Standard Conditions (kg/hr)	8.13

Method 5 data reduction

(datafile=sd_meth5)

Plant	South Dakota Cement
Run Number	M/5-03
Date of Run	05-June-1985
Operator	Chip Duke
Sampling Location	Stack #4 / Port A
Filter Type	Glass Fiber
Meter Box Identification	2102
Delta H@ (inches H2O)	2.23
Meter Correction Factor (dimensionless)	0.970
Start Time	10:53
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	70
Barometer (inches Hg)	26.36
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.790
Delta H (inches H2O)	0.66
Volume of Gas Sampled at Meter Conditions (ft3)	28.714
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Fahrenheit)	75.1
Average Stack Temperature (degrees Fahrenheit)	334.1
Nozzle Inside Diameter (inches)	0.1875
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	63.4
H2O Collected (ml)	69.5
Moisture in Stack Gas (percent by volume)	11.9
Isokinetic Rate (percent)	107.6
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	35.750
Total Mass Collected (mg.)	35.750
Gas Sampling Rate at Stack Conditions (ft3/min)	0.785
Volume of Gas Sampled at Normal Conditions (ft3)	24.258
Volume of Gas Sampled at Normal Conditions (m3)	0.687
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7210382
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	204175
Mass Emission Rate at Standard Conditions (lb/hr)	21.47
Mass Emission Rate at Standard Conditions (kg/hr)	10.63

Method 5 data reduction

(datafile=sd_meth5)

Plant	South Dakota Cement
Run Number	M/5-04
Date of Run	05-June-1985
Operator	Chip Duke
Sampling Location	Stack #4 / Port A
Filter Type	Glass Fiber
Meter Box Identification	2102
Delta H@ (inches H2O)	2.23
Meter Correction Factor (dimensionless)	0.970
Start Time	17:18
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	70
Barometer (inches Hg)	26.36
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.810
Delta H (inches H2O)	0.67
Volume of Gas Sampled at Meter Conditions (ft3)	28.365
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Fahrenheit)	84.1
Average Stack Temperature (degrees Fahrenheit)	349.3
Nozzle Inside Diameter (inches)	0.1875
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	64.8
H2O Collected (ml)	68.1
Moisture in Stack Gas (percent by volume)	12.0
Isokinetic Rate (percent)	104.3
Filter Mass (mg.)	0.090
Probe/Nozzle Wash Mass (mg.)	121.920
Total Mass Collected (mg.)	122.010
Gas Sampling Rate at Stack Conditions (ft3/min)	0.778
Volume of Gas Sampled at Normal Conditions (ft3)	23.567
Volume of Gas Sampled at Normal Conditions (m3)	0.667
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7224821
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	204584
Mass Emission Rate at Standard Conditions (lb/hr)	75.57
Mass Emission Rate at Standard Conditions (kg/hr)	37.40

Method 5 data reduction

(datafile=sd_meth5)

Plant	South Dakota Cement
Run Number	M/5-05
Date of Run	06-June-1985
Operator	Chip Duke
Sampling Location	Stack #4 / Port A
Filter Type	Quartz Fiber
Meter Box Identification	2102
Delta H@ (inches H2O)	2.23
Meter Correction Factor (dimensionless)	0.970
Start Time	09:50
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	70
Barometer (inches Hg)	26.44
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.52
Volume of Gas Sampled at Meter Conditions (ft3)	25.164
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Fahrenheit)	86.9
Average Stack Temperature (degrees Fahrenheit)	483.9
Nozzle Inside Diameter (inches)	0.1875
Relative Stack Static Pressure (inches H2O)	-0.57
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	65.9
H2O Collected (ml)	41.0
Moisture in Stack Gas (percent by volume)	8.5
Isokinetic Rate (percent)	101.5
Filter Mass (mg.)	1.408
Probe/Nozzle Wash Mass (mg.)	0.000
Total Mass Collected (mg.)	1.408
Gas Sampling Rate at Stack Conditions (ft3/min)	0.770
Volume of Gas Sampled at Normal Conditions (ft3)	20.855
Volume of Gas Sampled at Normal Conditions (m3)	0.591
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6568232
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185992
Mass Emission Rate at Standard Conditions (lb/hr)	0.90
Mass Emission Rate at Standard Conditions (kg/hr)	0.44

Method 5 data reduction

(datafile=sd_meth5)

Plant	South Dakota Cement
Run Number	M/5-06
Date of Run	06-June-1985
Operator	Chip Duke
Sampling Location	Stack #4 / Port A
Filter Type	Glass Fiber
Meter Box Identification	2102
Delta H@ (inches H2O)	2.23
Meter Correction Factor (dimensionless)	0.970
Start Time	15:15
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	80
Barometer (inches Hg)	26.44
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.52
Volume of Gas Sampled at Meter Conditions (ft3)	25.375
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	94.9
Average Stack Temperature (degrees Fahrenheit)	488.3
Nozzle Inside Diameter (inches)	0.1875
Relative Stack Static Pressure (inches H2O)	-0.57
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.2
H2O Collected (ml)	41.9
Moisture in Stack Gas (percent by volume)	8.7
Isokinetic Rate (percent)	101.2
Filter Mass (mg.)	0.219
Probe/Nozzle Wash Mass (mg.)	59.750
Total Mass Collected (mg.)	59.969
Gas Sampling Rate at Stack Conditions (ft3/min)	0.770
Volume of Gas Sampled at Normal Conditions (ft3)	20.726
Volume of Gas Sampled at Normal Conditions (m3)	0.587
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6547747
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185412
Mass Emission Rate at Standard Conditions (lb/hr)	38.28
Mass Emission Rate at Standard Conditions (kg/hr)	18.94

Method 5 data reduction

(datafile=sd_meth5)

Plant	South Dakota Cement
Run Number	M/5-07
Date of Run	11-June-1985
Operator	Chip Duke
Sampling Location	Stack #4 / Port A
Filter Type	Glass Fiber
Meter Box Identification	2102
Delta H@ (inches H2O)	2.23
Meter Correction Factor (dimensionless)	0.970
Start Time	11:20
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	52
Barometer (inches Hg)	26.77
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.690
Delta H (inches H2O)	0.48
Volume of Gas Sampled at Meter Conditions (ft3)	23.982
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	71.4
Average Stack Temperature (degrees Fahrenheit)	479.4
Nozzle Inside Diameter (inches)	0.1875
Relative Stack Static Pressure (inches H2O)	-0.45
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	64.1
H2O Collected (ml)	38.9
Moisture in Stack Gas (percent by volume)	8.1
Isokinetic Rate (percent)	101.5
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	68.750
Total Mass Collected (mg.)	68.750
Gas Sampling Rate at Stack Conditions (ft3/min)	0.748
Volume of Gas Sampled at Normal Conditions (ft3)	20.708
Volume of Gas Sampled at Normal Conditions (m3)	0.586
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6521568
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	184670
Mass Emission Rate at Standard Conditions (lb/hr)	43.75
Mass Emission Rate at Standard Conditions (kg/hr)	21.65

Method 5 data reduction

(datafile=sd_meth5)

Plant	South Dakota Cement
Run Number	M/5-08
Date of Run	12-June-1985
Operator	Chip Duke
Sampling Location	Stack #4 / Port A
Filter Type	Quartz Fiber
Meter Box Identification	2102
Delta H@ (inches H2O)	2.23
Meter Correction Factor (dimensionless)	0.970
Start Time	10:30
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	54
Barometer (inches Hg)	26.57
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.900
Delta H (inches H2O)	0.77
Volume of Gas Sampled at Meter Conditions (ft3)	29.623
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	63.2
Average Stack Temperature (degrees Fahrenheit)	335.0
Nozzle Inside Diameter (inches)	0.1875
Relative Stack Static Pressure (inches H2O)	-0.49
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	67.6
H2O Collected (ml)	65.7
Moisture in Stack Gas (percent by volume)	10.7
Isokinetic Rate (percent)	105.2
Filter Mass (mg.)	0.345
Probe/Nozzle Wash Mass (mg.)	26.880
Total Mass Collected (mg.)	27.225
Gas Sampling Rate at Stack Conditions (ft3/min)	0.818
Volume of Gas Sampled at Normal Conditions (ft3)	25.806
Volume of Gas Sampled at Normal Conditions (m3)	0.731
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7838775
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	221969
Mass Emission Rate at Standard Conditions (lb/hr)	16.71
Mass Emission Rate at Standard Conditions (kg/hr)	8.27

Method 5 data reduction

(datafile=sd_meth5)

Plant	South Dakota Cement
Run Number	M/5-09
Date of Run	12-June-1985
Operator	Chip Duke
Sampling Location	Stack #4 / Port A
Filter Type	Glass Fiber
Meter Box Identification	2102
Delta H@ (inches H2O)	2.23
Meter Correction Factor (dimensionless)	0.970
Start Time	16:00
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	65
Barometer (inches Hg)	26.57
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.950
Delta H (inches H2O)	0.80
Volume of Gas Sampled at Meter Conditions (ft3)	30.528
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	70.4
Average Stack Temperature (degrees Fahrenheit)	340.0
Nozzle Inside Diameter (inches)	0.1875
Relative Stack Static Pressure (inches H2O)	-0.49
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	69.6
H2O Collected (ml)	67.9
Moisture in Stack Gas (percent by volume)	10.9
Isokinetic Rate (percent)	104.7
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	29.730
Total Mass Collected (mg.)	29.730
Gas Sampling Rate at Stack Conditions (ft3/min)	0.838
Volume of Gas Sampled at Normal Conditions (ft3)	26.236
Volume of Gas Sampled at Normal Conditions (m3)	0.743
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	8014128
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	226935
Mass Emission Rate at Standard Conditions (lb/hr)	18.35
Mass Emission Rate at Standard Conditions (kg/hr)	9.08

Method 5 data reduction

(datafile=sd_meth5)

Plant	South Dakota Cement
Run Number	M/5-10
Date of Run	13-June-1985
Operator	Chip Duke
Sampling Location	Stack #4 / Port A
Filter Type	Quartz Fiber
Meter Box Identification	2102
Delta H@ (inches H2O)	2.23
Meter Correction Factor (dimensionless)	0.970
Start Time	08:30
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	70
Barometer (inches Hg)	26.30
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.50
Volume of Gas Sampled at Meter Conditions (ft3)	24.901
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	88.4
Average Stack Temperature (degrees Fahrenheit)	489.3
Nozzle Inside Diameter (inches)	0.1875
Relative Stack Static Pressure (inches H2O)	-0.43
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.4
H2O Collected (ml)	39.3
Moisture in Stack Gas (percent by volume)	8.3
Isokinetic Rate (percent)	99.8
Filter Mass (mg.)	0.288
Probe/Nozzle Wash Mass (mg.)	46.590
Total Mass Collected (mg.)	46.878
Gas Sampling Rate at Stack Conditions (ft3/min)	0.762
Volume of Gas Sampled at Normal Conditions (ft3)	20.470
Volume of Gas Sampled at Normal Conditions (m3)	0.580
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6556941
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185672
Mass Emission Rate at Standard Conditions (lb/hr)	30.34
Mass Emission Rate at Standard Conditions (kg/hr)	15.02

Method 5 data reduction

(datafile=sd_meth5)

Plant	South Dakota Cement
Run Number	M/5-11
Date of Run	13-June-1985
Operator	Chip Duke
Sampling Location	Stack #4 / Port A
Filter Type	Glass Fiber
Meter Box Identification	2102
Delta H@ (inches H2O)	2.23
Meter Correction Factor (dimensionless)	0.970
Start Time	12:15
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	75
Barometer (inches Hg)	26.30
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.50
Volume of Gas Sampled at Meter Conditions (ft3)	24.906
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	92.5
Average Stack Temperature (degrees Fahrenheit)	491.7
Nozzle Inside Diameter (inches)	0.1875
Relative Stack Static Pressure (inches H2O)	-0.43
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.4
H2O Collected (ml)	40.4
Moisture in Stack Gas (percent by volume)	8.6
Isokinetic Rate (percent)	99.5
Filter Mass (mg.)	0.026
Probe/Nozzle Wash Mass (mg.)	24.520
Total Mass Collected (mg.)	24.546
Gas Sampling Rate at Stack Conditions (ft3/min)	0.761
Volume of Gas Sampled at Normal Conditions (ft3)	20.323
Volume of Gas Sampled at Normal Conditions (m3)	0.575
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6529426
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	184893
Mass Emission Rate at Standard Conditions (lb/hr)	15.93
Mass Emission Rate at Standard Conditions (kg/hr)	7.89

APPENDIX B

PARTICULATE AND GAS SAMPLING CALCULATIONS

Paas data reduction

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	NH3-A-1
Date of Run	03-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port 4
Filter Type	Quartz
Meter Box Identification	#153800
Delta H@ (inches H2O)	2.04
Meter Correction Factor (dimensionless)	0.986
Start Time	16:57
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	60
Barometer (inches Hg)	26.56
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.23
Volume of Gas Sampled at Meter Conditions (ft3)	19.505
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	79.9
Average Stack Temperature (degrees Fahrenheit)	482.0
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.40
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	65.8
H2O Collected (ml)	34.0
Moisture in Stack Gas (percent by volume)	8.8
Isokinetic Rate (percent)	116.8
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	14.590
Total Mass Collected (mg.)	14.590
Gas Sampling Rate at Stack Conditions (ft3/min)	0.614
Volume of Gas Sampled at Normal Conditions (ft3)	16.707
Volume of Gas Sampled at Normal Conditions (m3)	0.473
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6582227
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	186388
Mass Emission Rate at Standard Conditions (lb/hr)	11.61
Mass Emission Rate at Standard Conditions (kg/hr)	5.75

Paas data reduction

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	NH3-B-1
Date of Run	03-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port 4
Filter Type	Quartz
Meter Box Identification	#008689
Delta H@ (inches H2O)	2.15
Meter Correction Factor (dimensionless)	0.995
Start Time	16:57
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	60
Barometer (inches Hg)	26.56
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.23
Volume of Gas Sampled at Meter Conditions (ft3)	22.105
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	76.7
Average Stack Temperature (degrees Fahrenheit)	482.0
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.40
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	65.8
H2O Collected (ml)	39.0
Moisture in Stack Gas (percent by volume)	8.7
Isokinetic Rate (percent)	134.3
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	21.630
Total Mass Collected (mg.)	21.630
Gas Sampling Rate at Stack Conditions (ft3/min)	0.706
Volume of Gas Sampled at Normal Conditions (ft3)	19.220
Volume of Gas Sampled at Normal Conditions (m3)	0.544
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6583934
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	186436
Mass Emission Rate at Standard Conditions (lb/hr)	14.97
Mass Emission Rate at Standard Conditions (kg/hr)	7.41

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	HCl/HF-Run 1A
Date of Run	04-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port E
Filter Type	Quartz
Meter Box Identification	#153800
Delta H@ (inches H2O)	2.04
Meter Correction Factor (dimensionless)	0.986
Start Time	13:29
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	n/a
Barometer (inches Hg)	26.61
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.920
Delta H (inches H2O)	0.35
Volume of Gas Sampled at Meter Conditions (ft3)	22.305
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Fahrenheit)	75.6
Average Stack Temperature (degrees Fahrenheit)	316.0
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	67.3
H2O Collected (ml)	51.8
Moisture in Stack Gas (percent by volume)	11.2
Isokinetic Rate (percent)	111.4
Filter Mass (mg.)	0.003
Probe/Nozzle Wash Mass (mg.)	1.000
Total Mass Collected (mg.)	1.003
Gas Sampling Rate at Stack Conditions (ft3/min)	0.600
Volume of Gas Sampled at Normal Conditions (ft3)	19.301
Volume of Gas Sampled at Normal Conditions (m3)	0.547
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7968625
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	225646
Mass Emission Rate at Standard Conditions (lb/hr)	0.84
Mass Emission Rate at Standard Conditions (kg/hr)	0.41

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	HCl/NF-Run 1B
Date of Run	04-June-1985
Operator	Jim Cheney
Sampling Location	Stack #4 / Port D
Filter Type	Quartz
Meter Box Identification	#008689
Delta H@ (inches H2O)	2.15
Meter Correction Factor (dimensionless)	0.995
Start Time	13:29
Length of Run (minutes)	30.0
Ambient Temp. (degrees Fahrenheit)	n/a
Barometer (inches Hg)	26.61
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.920
Delta H (inches H2O)	0.35
Volume of Gas Sampled at Meter Conditions (ft3)	7.756
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Fahrenheit)	68.0
Average Stack Temperature (degrees Fahrenheit)	316.0
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	67.3
H2O Collected (ml)	15.4
Moisture in Stack Gas (percent by volume)	9.6
Isokinetic Rate (percent)	77.9
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	0.000
Total Mass Collected (mg.)	0.000
Gas Sampling Rate at Stack Conditions (ft3/min)	0.419
Volume of Gas Sampled at Normal Conditions (ft3)	6.870
Volume of Gas Sampled at Normal Conditions (m3)	0.195
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	8119043
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	229906
Mass Emission Rate at Standard Conditions (lb/hr)	0.00
Mass Emission Rate at Standard Conditions (kg/hr)	0.00

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	HF/HCl-Run 2A
Date of Run	05-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port E
Filter Type	Quartz
Meter Box Identification	#153800
Delta H@ (inches H2O)	2.04
Meter Correction Factor (dimensionless)	0.986
Start Time	10:49
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	70
Barometer (inches Hg)	26.36
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.790
Delta H (inches H2O)	0.31
Volume of Gas Sampled at Meter Conditions (ft3)	21.629
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Fahrenheit)	81.0
Average Stack Temperature (degrees Fahrenheit)	334.1
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	63.4
H2O Collected (ml)	52.0
Moisture in Stack Gas (percent by volume)	11.8
Isokinetic Rate (percent)	116.9
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	0.560
Total Mass Collected (mg.)	0.560
Gas Sampling Rate at Stack Conditions (ft3/min)	0.593
Volume of Gas Sampled at Normal Conditions (ft3)	18.353
Volume of Gas Sampled at Normal Conditions (m3)	0.520
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7219921
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	204445
Mass Emission Rate at Standard Conditions (lb/hr)	0.45
Mass Emission Rate at Standard Conditions (kg/hr)	0.22

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	HF/HCl-Run 2B
Date of Run	05-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port D
Filter Type	Quartz
Meter Box Identification	#008689
Delta H@ (inches H2O)	2.15
Meter Correction Factor (dimensionless)	0.995
Start Time	10:49
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	70
Barometer (inches Hg)	26.36
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.790
Delta H (inches H2O)	0.32
Volume of Gas Sampled at Meter Conditions (ft3)	19.467
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Fahrenheit)	83.8
Average Stack Temperature (degrees Fahrenheit)	334.1
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	63.4
H2O Collected (ml)	46.1
Moisture in Stack Gas (percent by volume)	11.6
Isokinetic Rate (percent)	105.4
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	4.780
Total Mass Collected (mg.)	4.780
Gas Sampling Rate at Stack Conditions (ft3/min)	0.534
Volume of Gas Sampled at Normal Conditions (ft3)	16.584
Volume of Gas Sampled at Normal Conditions (m3)	0.470
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7236043
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	204902
Mass Emission Rate at Standard Conditions (lb/hr)	4.21
Mass Emission Rate at Standard Conditions (kg/hr)	2.09

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	NH3(PAAS)-2A
Date of Run	05-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port E
Filter Type	Quartz
Meter Box Identification	#153800
Delta H@ (inches H2O)	2.04
Meter Correction Factor (dimensionless)	0.986
Start Time	17:20
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	70
Barometer (inches Hg)	26.36
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.810
Delta H (inches H2O)	0.31
Volume of Gas Sampled at Meter Conditions (ft3)	21.550
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Fahrenheit)	91.3
Average Stack Temperature (degrees Fahrenheit)	349.3
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	64.8
H2O Collected (ml)	52.1
Moisture in Stack Gas (percent by volume)	12.1
Isokinetic Rate (percent)	114.3
Filter Mass (mg.)	0.075
Probe/Nozzle Wash Mass (mg.)	14.340
Total Mass Collected (mg.)	14.415
Gas Sampling Rate at Stack Conditions (ft3/min)	0.592
Volume of Gas Sampled at Normal Conditions (ft3)	17.944
Volume of Gas Sampled at Normal Conditions (m3)	0.508
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7220689
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	204467
Mass Emission Rate at Standard Conditions (lb/hr)	11.72
Mass Emission Rate at Standard Conditions (kg/hr)	5.80

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	NH3(PAAS)-2B
Date of Run	05-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port D
Filter Type	Quartz
Meter Box Identification	#008689
Delta H@ (inches H2O)	2.15
Meter Correction Factor (dimensionless)	0.995
Start Time	17:20
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	70
Barometer (inches Hg)	26.36
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.810
Delta H (inches H2O)	0.31
Volume of Gas Sampled at Meter Conditions (ft3)	19.893
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Fahrenheit)	91.4
Average Stack Temperature (degrees Fahrenheit)	349.3
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	64.8
H2O Collected (ml)	47.4
Moisture in Stack Gas (percent by volume)	11.8
Isokinetic Rate (percent)	106.2
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	16.360
Total Mass Collected (mg.)	16.360
Gas Sampling Rate at Stack Conditions (ft3/min)	0.550
Volume of Gas Sampled at Normal Conditions (ft3)	16.713
Volume of Gas Sampled at Normal Conditions (m3)	0.473
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7240907
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	205040
Mass Emission Rate at Standard Conditions (lb/hr)	14.32
Mass Emission Rate at Standard Conditions (kg/hr)	7.09

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	HF/HCl-Run 3A
Date of Run	06-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port E
Filter Type	Quartz
Meter Box Identification	#153800
Delta H@ (inches H2O)	2.04
Meter Correction Factor (dimensionless)	0.986
Start Time	09:50
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	70
Barometer (inches Hg)	26.44
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.22
Volume of Gas Sampled at Meter Conditions (ft3)	19.102
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Fahrenheit)	81.2
Average Stack Temperature (degrees Fahrenheit)	483.9
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.57
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	65.9
H2O Collected (ml)	6.5
Moisture in Stack Gas (percent by volume)	1.9
Isokinetic Rate (percent)	106.1
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	36.400
Total Mass Collected (mg.)	36.400
Gas Sampling Rate at Stack Conditions (ft3/min)	0.559
Volume of Gas Sampled at Normal Conditions (ft3)	16.248
Volume of Gas Sampled at Normal Conditions (m3)	0.460
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7044705
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	199484
Mass Emission Rate at Standard Conditions (lb/hr)	31.89
Mass Emission Rate at Standard Conditions (kg/hr)	15.78

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	HF/HCl-Run 3B
Date of Run	06-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port D
Filter Type	Quartz
Meter Box Identification	#008689
Delta H@ (inches H2O)	2.15
Meter Correction Factor (dimensionless)	0.995
Start Time	09:50
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	70
Barometer (inches Hg)	26.44
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.22
Volume of Gas Sampled at Meter Conditions (ft3)	17.535
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Fahrenheit)	77.3
Average Stack Temperature (degrees Fahrenheit)	483.9
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.57
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	65.9
H2O Collected (ml)	28.5
Moisture in Stack Gas (percent by volume)	8.1
Isokinetic Rate (percent)	105.8
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	23.580
Total Mass Collected (mg.)	23.580
Gas Sampling Rate at Stack Conditions (ft3/min)	0.557
Volume of Gas Sampled at Normal Conditions (ft3)	15.160
Volume of Gas Sampled at Normal Conditions (m3)	0.429
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6592745
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	186686
Mass Emission Rate at Standard Conditions (lb/hr)	20.72
Mass Emission Rate at Standard Conditions (kg/hr)	10.25

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	NH3(PAAS)-Run 3A
Date of Run	06-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port E
Filter Type	Quartz
Meter Box Identification	#153800
Delta H@ (inches H2O)	2.04
Meter Correction Factor (dimensionless)	0.986
Start Time	15:16
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	80
Barometer (inches Hg)	26.44
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.22
Volume of Gas Sampled at Meter Conditions (ft3)	18.742
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	94.7
Average Stack Temperature (degrees Fahrenheit)	488.3
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.57
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.2
H2O Collected (ml)	31.6
Moisture in Stack Gas (percent by volume)	8.8
Isokinetic Rate (percent)	109.3
Filter Mass (mg.)	0.032
Probe/Nozzle Wash Mass (mg.)	18.720
Total Mass Collected (mg.)	18.752
Gas Sampling Rate at Stack Conditions (ft3/min)	0.578
Volume of Gas Sampled at Normal Conditions (ft3)	15.554
Volume of Gas Sampled at Normal Conditions (m3)	0.440
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6544900
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185331
Mass Emission Rate at Standard Conditions (lb/hr)	15.94
Mass Emission Rate at Standard Conditions (kg/hr)	7.89

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	NH3(PAAS)-Run 3B
Date of Run	06-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port D
Filter Type	Quartz
Meter Box Identification	#008689
Delta H@ (inches H2O)	2.15
Meter Correction Factor (dimensionless)	0.995
Start Time	15:16
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	80
Barometer (inches Hg)	26.44
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.22
Volume of Gas Sampled at Meter Conditions (ft3)	17.189
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	90.9
Average Stack Temperature (degrees Fahrenheit)	488.3
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.57
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.2
H2O Collected (ml)	29.0
Moisture in Stack Gas (percent by volume)	8.6
Isokinetic Rate (percent)	101.8
Filter Mass (mg.)	0.015
Probe/Nozzle Wash Mass (mg.)	39.140
Total Mass Collected (mg.)	39.155
Gas Sampling Rate at Stack Conditions (ft3/min)	0.538
Volume of Gas Sampled at Normal Conditions (ft3)	14.494
Volume of Gas Sampled at Normal Conditions (m3)	0.410
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6553621
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185578
Mass Emission Rate at Standard Conditions (lb/hr)	35.77
Mass Emission Rate at Standard Conditions (kg/hr)	17.70

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	NH3(PAAS)-Run 4A
Date of Run	11-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port E
Filter Type	Quartz
Meter Box Identification	#153800
Delta H@ (inches H2O)	2.04
Meter Correction Factor (dimensionless)	0.986
Start Time	11:17
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	52
Barometer (inches Hg)	26.77
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.690
Delta H (inches H2O)	0.21
Volume of Gas Sampled at Meter Conditions (ft3)	16.935
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	59.0
Average Stack Temperature (degrees Fahrenheit)	475.0
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.45
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	63.9
H2O Collected (ml)	32.0
Moisture in Stack Gas (percent by volume)	9.0
Isokinetic Rate (percent)	108.1
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	54.250
Total Mass Collected (mg.)	54.250
Gas Sampling Rate at Stack Conditions (ft3/min)	0.552
Volume of Gas Sampled at Normal Conditions (ft3)	15.208
Volume of Gas Sampled at Normal Conditions (m3)	0.431
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6473564
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	183311
Mass Emission Rate at Standard Conditions (lb/hr)	46.66
Mass Emission Rate at Standard Conditions (kg/hr)	23.09

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	NH3(PAAS)-Run 4B
Date of Run	11-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port D
Filter Type	Quartz
Meter Box Identification	#008689
Delta H@ (inches H2O)	2.15
Meter Correction Factor (dimensionless)	0.995
Start Time	11:17
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	52
Barometer (inches Hg)	26.77
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.690
Delta H (inches H2O)	0.21
Volume of Gas Sampled at Meter Conditions (ft3)	16.110
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	57.3
Average Stack Temperature (degrees Fahrenheit)	480.0
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.45
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	64.1
H2O Collected (ml)	30.2
Moisture in Stack Gas (percent by volume)	8.9
Isokinetic Rate (percent)	104.2
Filter Mass (mg.)	0.245
Probe/Nozzle Wash Mass (mg.)	64.410
Total Mass Collected (mg.)	64.655
Gas Sampling Rate at Stack Conditions (ft3/min)	0.534
Volume of Gas Sampled at Normal Conditions (ft3)	14.647
Volume of Gas Sampled at Normal Conditions (m3)	0.415
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6468078
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	183156
Mass Emission Rate at Standard Conditions (lb/hr)	57.69
Mass Emission Rate at Standard Conditions (kg/hr)	28.55

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	HF/HCl-Run #4B
Date of Run	12-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port D
Filter Type	Quartz
Meter Box Identification	#008689
Delta H@ (inches H2O)	2.15
Meter Correction Factor (dimensionless)	0.995
Start Time	10:30
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	54
Barometer (inches Hg)	26.57
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.900
Delta H (inches H2O)	0.35
Volume of Gas Sampled at Meter Conditions (ft3)	21.263
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	74.6
Average Stack Temperature (degrees Fahrenheit)	340.0
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.49
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	67.8
H2O Collected (ml)	46.3
Moisture in Stack Gas (percent by volume)	10.5
Isokinetic Rate (percent)	109.1
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	21.140
Total Mass Collected (mg.)	21.140
Gas Sampling Rate at Stack Conditions (ft3/min)	0.591
Volume of Gas Sampled at Normal Conditions (ft3)	18.574
Volume of Gas Sampled at Normal Conditions (m3)	0.526
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7831787
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	221771
Mass Emission Rate at Standard Conditions (lb/hr)	18.01
Mass Emission Rate at Standard Conditions (kg/hr)	8.91

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	NH3(PAAS)-Run 5A
Date of Run	12-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port E
Filter Type	Quartz
Meter Box Identification	#153800
Delta H@ (inches H2O)	2.04
Meter Correction Factor (dimensionless)	0.986
Start Time	16:00
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	65
Barometer (inches Hg)	26.57
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.950
Delta H (inches H2O)	0.35
Volume of Gas Sampled at Meter Conditions (ft3)	24.024
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	79.4
Average Stack Temperature (degrees Fahrenheit)	344.0
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.49
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	69.8
H2O Collected (ml)	53.0
Moisture in Stack Gas (percent by volume)	10.8
Isokinetic Rate (percent)	118.5
Filter Mass (mg.)	0.022
Probe/Nozzle Wash Mass (mg.)	18.710
Total Mass Collected (mg.)	18.732
Gas Sampling Rate at Stack Conditions (ft3/min)	0.661
Volume of Gas Sampled at Normal Conditions (ft3)	20.611
Volume of Gas Sampled at Normal Conditions (m3)	0.584
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7999762
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	226528
Mass Emission Rate at Standard Conditions (lb/hr)	14.69
Mass Emission Rate at Standard Conditions (kg/hr)	7.27

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	NH3(PAAS)-Run 5B
Date of Run	12-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port D
Filter Type	Quartz
Meter Box Identification	#008689
Delta H@ (inches H2O)	2.15
Meter Correction Factor (dimensionless)	0.995
Start Time	16:00
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	65
Barometer (inches Hg)	26.57
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.950
Delta H (inches H2O)	0.37
Volume of Gas Sampled at Meter Conditions (ft3)	21.707
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	79.1
Average Stack Temperature (degrees Fahrenheit)	344.0
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.49
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	69.8
H2O Collected (ml)	48.2
Moisture in Stack Gas (percent by volume)	10.8
Isokinetic Rate (percent)	108.1
Filter Mass (mg.)	0.068
Probe/Nozzle Wash Mass (mg.)	26.490
Total Mass Collected (mg.)	26.558
Gas Sampling Rate at Stack Conditions (ft3/min)	0.603
Volume of Gas Sampled at Normal Conditions (ft3)	18.805
Volume of Gas Sampled at Normal Conditions (m3)	0.532
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	8002540
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	226607
Mass Emission Rate at Standard Conditions (lb/hr)	22.84
Mass Emission Rate at Standard Conditions (kg/hr)	11.30

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	HF/HCl-Run 5A
Date of Run	13-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port E
Filter Type	Quartz
Meter Box Identification	#153800
Delta H@ (inches H2O)	2.04
Meter Correction Factor (dimensionless)	0.986
Start Time	08:30
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	70
Barometer (inches Hg)	26.30
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.21
Volume of Gas Sampled at Meter Conditions (ft3)	19.374
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	91.6
Average Stack Temperature (degrees Fahrenheit)	489.3
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.43
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.4
H2O Collected (ml)	17.0
Moisture in Stack Gas (percent by volume)	4.8
Isokinetic Rate (percent)	108.6
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	14.710
Total Mass Collected (mg.)	14.710
Gas Sampling Rate at Stack Conditions (ft3/min)	0.576
Volume of Gas Sampled at Normal Conditions (ft3)	16.083
Volume of Gas Sampled at Normal Conditions (m3)	0.455
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6811277
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	192874
Mass Emission Rate at Standard Conditions (lb/hr)	12.59
Mass Emission Rate at Standard Conditions (kg/hr)	6.23

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	HF/HCl-Run 5B
Date of Run	13-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port D
Filter Type	Quartz
Meter Box Identification	#008689
Delta H@ (inches H2O)	2.15
Meter Correction Factor (dimensionless)	0.995
Start Time	08:30
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	70
Barometer (inches Hg)	26.30
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.22
Volume of Gas Sampled at Meter Conditions (ft3)	17.173
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	87.0
Average Stack Temperature (degrees Fahrenheit)	491.5
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.43
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.4
H2O Collected (ml)	26.6
Moisture in Stack Gas (percent by volume)	8.0
Isokinetic Rate (percent)	101.5
Filter Mass (mg.)	0.035
Probe/Nozzle Wash Mass (mg.)	15.340
Total Mass Collected (mg.)	15.375
Gas Sampling Rate at Stack Conditions (ft3/min)	0.539
Volume of Gas Sampled at Normal Conditions (ft3)	14.507
Volume of Gas Sampled at Normal Conditions (m3)	0.411
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6573894
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	186152
Mass Emission Rate at Standard Conditions (lb/hr)	14.08
Mass Emission Rate at Standard Conditions (kg/hr)	6.97

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	NH3(PAAS)-Run 6A
Date of Run	13-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port E
Filter Type	Quartz
Meter Box Identification	#153800
Delta H@ (inches H2O)	2.04
Meter Correction Factor (dimensionless)	0.986
Start Time	12:15
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	75
Barometer (inches Hg)	26.30
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.21
Volume of Gas Sampled at Meter Conditions (ft3)	19.762
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	100.9
Average Stack Temperature (degrees Fahrenheit)	492.5
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.43
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.5
H2O Collected (ml)	31.6
Moisture in Stack Gas (percent by volume)	8.5
Isokinetic Rate (percent)	113.6
Filter Mass (mg.)	0.000
Probe/Nozzle Wash Mass (mg.)	26.130
Total Mass Collected (mg.)	26.130
Gas Sampling Rate at Stack Conditions (ft3/min)	0.604
Volume of Gas Sampled at Normal Conditions (ft3)	16.133
Volume of Gas Sampled at Normal Conditions (m3)	0.457
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6534911
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185048
Mass Emission Rate at Standard Conditions (lb/hr)	21.39
Mass Emission Rate at Standard Conditions (kg/hr)	10.58

*** Paas data reduction ***

(datafile=sd_paas)

Plant	South Dakota Cement
Run Number	HF/HCl-Run 6B
Date of Run	13-June-1985
Operator	Chris Fortune
Sampling Location	Stack #4 / Port D
Filter Type	Quartz
Meter Box Identification	#008689
Delta H@ (inches H2O)	2.15
Meter Correction Factor (dimensionless)	0.995
Start Time	12:15
Length of Run (minutes)	60.0
Ambient Temp. (degrees Fahrenheit)	75
Barometer (inches Hg)	26.30
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.720
Delta H (inches H2O)	0.22
Volume of Gas Sampled at Meter Conditions (ft3)	17.451
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Fahrenheit)	100.4
Average Stack Temperature (degrees Fahrenheit)	498.0
Nozzle Inside Diameter (inches)	0.1563
Relative Stack Static Pressure (inches H2O)	-0.43
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.7
H2O Collected (ml)	27.4
Moisture in Stack Gas (percent by volume)	8.2
Isokinetic Rate (percent)	101.4
Filter Mass (mg.)	0.064
Probe/Nozzle Wash Mass (mg.)	7.810
Total Mass Collected (mg.)	7.874
Gas Sampling Rate at Stack Conditions (ft3/min)	0.540
Volume of Gas Sampled at Normal Conditions (ft3)	14.389
Volume of Gas Sampled at Normal Conditions (m3)	0.407
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6531526
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	184952
Mass Emission Rate at Standard Conditions (lb/hr)	7.22
Mass Emission Rate at Standard Conditions (kg/hr)	3.57

APPENDIX C

PILAT IMPACTOR CALCULATIONS

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-1
Date of Run	04-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port C
Impaction Substrate	Type H
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	15:04
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	n/a
Barometer (inches Hg)	26.61
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.92
Delta H (inches H2O)	0.20
Volume of Gas Sampled at Meter Conditions (ft3)	16.460
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Farenheit)	69.6
Average Stack Temperature (degrees Farenheit)	336.6
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	68.2
Assumed Moisture in Stack Gas (percent by volume)	11.2
Isokinetic Rate (percent)	101.1
Gas Sampling Rate at Stack Conditions (ft3/min)	0.442
Volume of Gas Sampled at Normal Conditions (ft3)	13.873
Volume of Gas Sampled at Normal Conditions (m3)	0.393
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7868761
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	222818
Mass Emission Rate at Standard Conditions (lb/hr)	3.93
Mass Emission Rate at Standard Conditions (kg/hr)	1.95

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.068	2.0	2.0	0.173	21.65	0.04
Stage 2	0.059	1.7	3.7	0.150	16.31	0.03
Stage 3	0.000	0.0	3.7	0.000	6.25	0.00
Stage 4	0.000	0.0	3.7	0.000	3.10	0.00
Stage 5	0.020	0.6	4.3	0.051	1.74	0.01
Stage 6	0.000	0.0	4.3	0.000	0.93	0.00
Stage 7	0.003	0.1	4.4	0.008	0.51	0.00
Filter	3.283	95.6	100.0	8.357	n/a	1.86
TOTAL	3.433	100.0	100.0	8.739	n/a	1.95

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-2
Date of Run	05-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port C
Impaction Substrate	Quartz (NH4+)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	11:30
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	70
Barometer (inches Hg)	26.36
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.72
Delta H (inches H2O)	0.16
Volume of Gas Sampled at Meter Conditions (ft3)	15.200
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Farenheit)	75.3
Average Stack Temperature (degrees Farenheit)	334.5
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	60.5
Assumed Moisture in Stack Gas (percent by volume)	11.9
Isokinetic Rate (percent)	104.6
Gas Sampling Rate at Stack Conditions (ft3/min)	0.406
Volume of Gas Sampled at Normal Conditions (ft3)	12.554
Volume of Gas Sampled at Normal Conditions (m3)	0.355
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6882754
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	194898
Mass Emission Rate at Standard Conditions (lb/hr)	0.09
Mass Emission Rate at Standard Conditions (kg/hr)	0.04

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.006	7.5	107.5	0.017	22.57	0.00
Stage 2	0.004	5.0	112.5	0.011	17.01	0.00
Stage 3	0.014	17.5	130.0	0.039	6.52	0.01
Stage 4	0.013	16.3	146.2	0.037	3.24	0.01
Stage 5	0.009	11.2	157.5	0.025	1.82	0.00
Stage 6	0.014	17.5	175.0	0.039	0.97	0.01
Stage 7	0.012	15.0	190.0	0.034	0.53	0.01
Filter	0.008	10.0	200.0	0.023	n/a	0.00
TOTAL	0.080	100.0	100.0	0.225	n/a	0.04

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-3
Date of Run	05-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	15:55
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	70
Barometer (inches Hg)	26.36
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.72
Delta H (inches H2O)	0.16
Volume of Gas Sampled at Meter Conditions (ft3)	15.282
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Farenheit)	81.4
Average Stack Temperature (degrees Farenheit)	334.1
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	60.5
Assumed Moisture in Stack Gas (percent by volume)	11.9
Isokinetic Rate (percent)	103.9
Gas Sampling Rate at Stack Conditions (ft3/min)	0.404
Volume of Gas Sampled at Normal Conditions (ft3)	12.479
Volume of Gas Sampled at Normal Conditions (m3)	0.353
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6884487
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	194947
Mass Emission Rate at Standard Conditions (lb/hr)	0.01
Mass Emission Rate at Standard Conditions (kg/hr)	0.01

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.000	0.0	100.0	0.000	22.64	0.00
Stage 2	0.000	0.0	100.0	0.000	17.06	0.00
Stage 3	0.001	10.0	110.0	0.003	6.54	0.00
Stage 4	0.000	0.0	110.0	0.000	3.25	0.00
Stage 5	0.000	0.0	110.0	0.000	1.83	0.00
Stage 6	0.005	50.0	160.0	0.014	0.98	0.00
Stage 7	0.000	0.0	160.0	0.000	0.53	0.00
Filter	0.004	40.0	200.0	0.011	n/a	0.00
TOTAL	0.010	100.0	100.0	0.028	n/a	0.01

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-4
Date of Run	05-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz (NH4+)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	17:25
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	70
Barometer (inches Hg)	26.36
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.92
Delta H (inches H2O)	0.20
Volume of Gas Sampled at Meter Conditions (ft3)	16.803
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Farenheit)	82.8
Average Stack Temperature (degrees Farenheit)	349.3
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	69.1
Assumed Moisture in Stack Gas (percent by volume)	12.0
Isokinetic Rate (percent)	101.9
Gas Sampling Rate at Stack Conditions (ft3/min)	0.452
Volume of Gas Sampled at Normal Conditions (ft3)	13.688
Volume of Gas Sampled at Normal Conditions (m3)	0.388
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7699966
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	218039
Mass Emission Rate at Standard Conditions (lb/hr)	0.08
Mass Emission Rate at Standard Conditions (kg/hr)	0.04

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.011	15.1	115.1	0.028	21.55	0.01
Stage 2	0.006	8.2	123.3	0.015	16.23	0.00
Stage 3	0.010	13.7	137.0	0.026	6.22	0.01
Stage 4	0.001	1.4	138.4	0.003	3.09	0.00
Stage 5	0.008	11.0	149.3	0.021	1.73	0.00
Stage 6	0.004	5.5	154.8	0.010	0.93	0.00
Stage 7	0.011	15.1	169.9	0.028	0.50	0.01
Filter	0.022	30.1	200.0	0.057	n/a	0.01
TOTAL	0.073	100.0	100.0	0.188	n/a	0.04

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-4
Date of Run	05-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	17.25
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	70
Barometer (inches Hg)	26.36
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.92
Delta H (inches H2O)	0.20
Volume of Gas Sampled at Meter Conditions (ft3)	16.803
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Farenheit)	82.8
Average Stack Temperature (degrees Farenheit)	349.3
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	69.1
Assumed Moisture in Stack Gas (percent by volume)	12.0
Isokinetic Rate (percent)	101.9
Gas Sampling Rate at Stack Conditions (ft3/min)	0.452
Volume of Gas Sampled at Normal Conditions (ft3)	13.688
Volume of Gas Sampled at Normal Conditions (m3)	0.388
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7699966
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	218039
Mass Emission Rate at Standard Conditions (lb/hr)	1.97
Mass Emission Rate at Standard Conditions (kg/hr)	0.97

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.441	25.4	125.4	1.138	21.55	0.25
Stage 2	0.581	33.5	159.0	1.499	10.23	0.33
Stage 3	0.612	35.3	194.3	1.579	6.22	0.34
Stage 4	0.000	0.0	194.3	0.000	3.09	0.00
Stage 5	0.099	5.7	200.0	0.255	1.73	0.06
Stage 6	0.000	0.0	200.0	0.000	0.93	0.00
Stage 7	0.000	0.0	200.0	0.000	0.50	0.00
Filter	0.000	0.0	200.0	0.000	n/a	0.00
TOTAL	1.733	100.0	100.0	4.471	n/a	0.97

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-5
Date of Run	06-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz (NH4+)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	10:47
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	70
Barometer (inches Hg)	26.44
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.72
Delta H (inches H2O)	0.15
Volume of Gas Sampled at Meter Conditions (ft3)	14.838
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Farenheit)	101.3
Average Stack Temperature (degrees Farenheit)	486.0
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.57
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.0
Assumed Moisture in Stack Gas (percent by volume)	8.5
Isokinetic Rate (percent)	102.5
Gas Sampling Rate at Stack Conditions (ft3/min)	0.434
Volume of Gas Sampled at Normal Conditions (ft3)	11.722
Volume of Gas Sampled at Normal Conditions (m3)	0.332
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6560326
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185768
Mass Emission Rate at Standard Conditions (lb/hr)	0.12
Mass Emission Rate at Standard Conditions (kg/hr)	0.06

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.011	10.4	110.4	0.033	23.34	0.01
Stage 2	0.008	7.5	117.9	0.024	17.58	0.00
Stage 3	0.012	11.3	129.2	0.036	6.74	0.01
Stage 4	0.017	16.0	145.3	0.051	3.35	0.01
Stage 5	0.013	12.3	157.5	0.039	1.88	0.01
Stage 6	0.016	15.1	172.6	0.048	1.01	0.01
Stage 7	0.013	12.3	184.9	0.039	0.55	0.01
Filter	0.016	15.1	200.0	0.048	n/a	0.01
TOTAL	0.106	100.0	100.0	0.319	n/a	0.06

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-6
Date of Run	06-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz (NH4+)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	15:05
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	80
Barometer (inches Hg)	26.44
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.72
Delta H (inches H2O)	0.15
Volume of Gas Sampled at Meter Conditions (ft3)	14.638
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	101.8
Average Stack Temperature (degrees Farenheit)	486.0
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.57
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.1
Assumed Moisture in Stack Gas (percent by volume)	8.7
Isokinetic Rate (percent)	101.1
Gas Sampling Rate at Stack Conditions (ft3/min)	0.428
Volume of Gas Sampled at Normal Conditions (ft3)	11.554
Volume of Gas Sampled at Normal Conditions (m3)	0.327
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6556468
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185658
Mass Emission Rate at Standard Conditions (lb/hr)	0.09
Mass Emission Rate at Standard Conditions (kg/hr)	0.04

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.019	24.4	124.4	0.058	23.48	0.01
Stage 2	0.008	10.3	134.6	0.024	17.69	0.00
Stage 3	0.013	16.7	151.3	0.040	6.79	0.01
Stage 4	0.001	1.3	152.6	0.003	3.37	0.00
Stage 5	0.006	7.7	160.3	0.018	1.90	0.00
Stage 6	0.008	10.3	170.5	0.024	1.02	0.00
Stage 7	0.014	17.9	188.5	0.043	0.56	0.01
Filter	0.009	11.5	200.0	0.028	n/a	0.01
TOTAL	0.078	100.0	100.0	0.238	n/a	0.04

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-7
Date of Run	06-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz (NH4+)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	17:07
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	80
Barometer (inches Hg)	26.44
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.72
Delta H (inches H2O)	0.15
Volume of Gas Sampled at Meter Conditions (ft3)	14.594
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	95.8
Average Stack Temperature (degrees Farenheit)	488.3
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.57
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.2
Assumed Moisture in Stack Gas (percent by volume)	8.7
Isokinetic Rate (percent)	102.0
Gas Sampling Rate at Stack Conditions (ft3/min)	0.433
Volume of Gas Sampled at Normal Conditions (ft3)	11.644
Volume of Gas Sampled at Normal Conditions (m3)	0.330
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6548512
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185433
Mass Emission Rate at Standard Conditions (lb/hr)	0.06
Mass Emission Rate at Standard Conditions (kg/hr)	0.03

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.010	17.9	117.9	0.030	23.38	0.01
Stage 2	0.007	12.5	130.4	0.021	17.62	0.00
Stage 3	0.007	12.5	142.9	0.021	6.76	0.00
Stage 4	0.011	19.6	162.5	0.033	3.36	0.01
Stage 5	0.005	8.9	171.4	0.015	1.89	0.00
Stage 6	0.006	10.7	182.1	0.018	1.01	0.00
Stage 7	0.005	8.9	191.1	0.015	0.55	0.00
Filter	0.005	8.9	200.0	0.015	n/a	0.00
TOTAL	0.056	100.0	100.0	0.170	n/a	0.03

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-7
Date of Run	06-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	17:07
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	80
Barometer (inches Hg)	26.44
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.72
Delta H (inches H2O)	0.15
Volume of Gas Sampled at Meter Conditions (ft3)	14.594
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	95.8
Average Stack Temperature (degrees Farenheit)	488.3
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.57
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.2
Assumed Moisture in Stack Gas (percent by volume)	8.7
Isokinetic Rate (percent)	102.0
Gas Sampling Rate at Stack Conditions (ft3/min)	0.433
Volume of Gas Sampled at Normal Conditions (ft3)	11.644
Volume of Gas Sampled at Normal Conditions (m3)	0.330
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6548512
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185433
Mass Emission Rate at Standard Conditions (lb/hr)	4.30
Mass Emission Rate at Standard Conditions (kg/hr)	2.13

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.354	9.4	109.4	1.074	23.38	0.20
Stage 2	0.211	5.6	114.9	0.640	17.62	0.12
Stage 3	0.628	16.6	131.5	1.905	6.76	0.35
Stage 4	0.892	23.6	155.1	2.705	3.36	0.50
Stage 5	0.478	12.6	167.7	1.450	1.89	0.27
Stage 6	0.510	13.5	181.2	1.547	1.01	0.29
Stage 7	0.713	18.8	200.0	2.162	0.55	0.40
Filter	0.000	0.0	200.0	0.000	n/a	0.00
TOTAL	3.786	100.0	100.0	11.483	n/a	2.13

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-8
Date of Run	11-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Stainless Steel
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	12:15
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	52
Barometer (inches Hg)	26.77
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.69
Delta H (inches H2O)	0.14
Volume of Gas Sampled at Meter Conditions (ft3)	13.264
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	69.8
Average Stack Temperature (degrees Farenheit)	478.0
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.45
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	64.0
Assumed Moisture in Stack Gas (percent by volume)	8.1
Isokinetic Rate (percent)	98.7
Gas Sampling Rate at Stack Conditions (ft3/min)	0.405
Volume of Gas Sampled at Normal Conditions (ft3)	11.240
Volume of Gas Sampled at Normal Conditions (m3)	0.318
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6529599
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	184898
Mass Emission Rate at Standard Conditions (lb/hr)	0.18
Mass Emission Rate at Standard Conditions (kg/hr)	0.09

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.045	29.8	129.8	0.141	24.06	0.03
Stage 2	0.033	21.9	151.7	0.104	18.13	0.02
Stage 3	0.001	0.7	152.3	0.003	6.96	0.00
Stage 4	0.016	10.6	162.9	0.050	3.45	0.01
Stage 5	0.000	0.0	162.9	0.000	1.95	0.00
Stage 6	0.056	37.1	200.0	0.176	1.04	0.03
Stage 7	0.000	0.0	200.0	0.000	0.57	0.00
Filter	0.000	0.0	200.0	0.000	n/a	0.00
TOTAL	0.151	100.0	100.0	0.474	n/a	0.09

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-9
Date of Run	11-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz (NH4+)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	15:05
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	52
Barometer (inches Hg)	26.77
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.69
Delta H (inches H2O)	0.14
Volume of Gas Sampled at Meter Conditions (ft3)	13.280
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	67.5
Average Stack Temperature (degrees Farenheit)	479.4
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.45
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	64.1
Assumed Moisture in Stack Gas (percent by volume)	8.1
Isokinetic Rate (percent)	99.3
Gas Sampling Rate at Stack Conditions (ft3/min)	0.408
Volume of Gas Sampled at Normal Conditions (ft3)	11.303
Volume of Gas Sampled at Normal Conditions (m3)	0.320
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6524732
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	184760
Mass Emission Rate at Standard Conditions (lb/hr)	0.14
Mass Emission Rate at Standard Conditions (kg/hr)	0.07

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.046	37.7	137.7	0.144	23.99	0.03
Stage 2	0.016	13.1	150.8	0.050	18.08	0.01
Stage 3	0.018	14.8	165.6	0.056	6.93	0.01
Stage 4	0.005	4.1	169.7	0.016	3.44	0.00
Stage 5	0.011	9.0	178.7	0.034	1.94	0.01
Stage 6	0.014	11.5	190.2	0.044	1.04	0.01
Stage 7	0.010	8.2	198.4	0.031	0.57	0.01
Filter	0.002	1.6	200.0	0.006	n/a	0.00
TOTAL	0.122	100.0	100.0	0.381	n/a	0.07

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-10 (extractive)
Date of Run	12-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port C
Impaction Substrate	Type H
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	10:00
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	54
Barometer (inches Hg)	26.57
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.90
Delta H (inches H2O)	0.77
Volume of Gas Sampled at Meter Conditions (ft3)	29.400
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	60.9
Average Stack Temperature (degrees Farenheit)	331.0
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.49
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	67.4
Assumed Moisture in Stack Gas (percent by volume)	10.7
Isokinetic Rate (percent)	183.8
Gas Sampling Rate at Stack Conditions (ft3/min)	0.794
Volume of Gas Sampled at Normal Conditions (ft3)	25.194
Volume of Gas Sampled at Normal Conditions (m3)	0.713
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7861001
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	222599
Mass Emission Rate at Standard Conditions (lb/hr)	2.53
Mass Emission Rate at Standard Conditions (kg/hr)	1.25

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.114	2.8	102.8	0.160	16.09	0.04
Stage 2	0.092	2.3	105.1	0.129	12.12	0.03
Stage 3	0.052	1.3	106.4	0.073	4.63	0.02
Stage 4	0.055	1.4	107.8	0.077	2.29	0.02
Stage 5	0.055	1.4	109.2	0.077	1.28	0.02
Stage 6	0.000	0.0	109.2	0.000	0.67	0.00
Stage 7	0.156	3.9	113.1	0.219	0.36	0.05
Filter	3.484	86.9	200.0	4.883	n/a	1.09
TOTAL	4.008	100.0	100.0	5.618	n/a	1.25

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-11 (extractive)
Date of Run	12-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz (NH4+)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	12:30
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	54
Barometer (inches Hg)	26.57
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.90
Delta H (inches H2O)	0.77
Volume of Gas Sampled at Meter Conditions (ft3)	29.471
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	65.5
Average Stack Temperature (degrees Farenheit)	337.0
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.49
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	67.6
Assumed Moisture in Stack Gas (percent by volume)	10.7
Isokinetic Rate (percent)	183.3
Gas Sampling Rate at Stack Conditions (ft3/min)	0.795
Volume of Gas Sampled at Normal Conditions (ft3)	25.034
Volume of Gas Sampled at Normal Conditions (m3)	0.709
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7831355
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	221759
Mass Emission Rate at Standard Conditions (lb/hr)	0.07
Mass Emission Rate at Standard Conditions (kg/hr)	0.04

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.017	15.2	115.2	0.024	16.13	0.01
Stage 2	0.019	17.0	132.1	0.027	12.14	0.01
Stage 3	0.015	13.4	145.5	0.021	4.64	0.00
Stage 4	0.010	8.9	154.5	0.014	2.29	0.00
Stage 5	0.012	10.7	165.2	0.017	1.28	0.00
Stage 6	0.008	7.1	172.3	0.011	0.68	0.00
Stage 7	0.012	10.7	183.0	0.017	0.36	0.00
Filter	0.019	17.0	200.0	0.027	n/a	0.01
TOTAL	0.112	100.0	100.0	0.158	n/a	0.04

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-12 (extractive)
Date of Run	12-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port C
Impaction Substrate	Stainless Steel
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	15:15
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	65
Barometer (inches Hg)	26.57
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.95
Delta H (inches H2O)	0.77
Volume of Gas Sampled at Meter Conditions (ft3)	29.722
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	67.8
Average Stack Temperature (degrees Farenheit)	342.0
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.49
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	69.7
Assumed Moisture in Stack Gas (percent by volume)	10.9
Isokinetic Rate (percent)	180.1
Gas Sampling Rate at Stack Conditions (ft3/min)	0.805
Volume of Gas Sampled at Normal Conditions (ft3)	25.137
Volume of Gas Sampled at Normal Conditions (m3)	0.712
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	8002869
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	226616
Mass Emission Rate at Standard Conditions (lb/hr)	2.57
Mass Emission Rate at Standard Conditions (kg/hr)	1.27

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.281	7.0	107.0	0.395	16.06	0.09
Stage 2	0.113	2.8	109.9	0.159	12.10	0.04
Stage 3	0.023	0.6	110.4	0.032	4.62	0.01
Stage 4	0.037	0.9	111.4	0.052	2.28	0.01
Stage 5	0.051	1.3	112.6	0.072	1.27	0.02
Stage 6	0.036	0.9	113.5	0.051	0.67	0.01
Stage 7	0.035	0.9	114.4	0.049	0.36	0.01
Filter	3.423	85.6	200.0	4.809	n/a	1.09
TOTAL	3.999	100.0	100.0	5.618	n/a	1.27

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-13 (extractive)
Date of Run	13-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port C
Impaction Substrate	Stainless Steel
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	09:30
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	70
Barometer (inches Hg)	26.30
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.72
Delta H (inches H2O)	0.50
Volume of Gas Sampled at Meter Conditions (ft3)	25.369
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	92.1
Average Stack Temperature (degrees Farenheit)	489.0
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.43
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.3
Assumed Moisture in Stack Gas (percent by volume)	8.3
Isokinetic Rate (percent)	177.4
Gas Sampling Rate at Stack Conditions (ft3/min)	0.755
Volume of Gas Sampled at Normal Conditions (ft3)	20.288
Volume of Gas Sampled at Normal Conditions (m3)	0.574
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6558604
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185719
Mass Emission Rate at Standard Conditions (lb/hr)	3.56
Mass Emission Rate at Standard Conditions (kg/hr)	1.76

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.122	2.2	102.2	0.212	17.69	0.04
Stage 2	1.606	29.5	131.7	2.795	13.32	0.52
Stage 3	0.031	0.6	132.3	0.054	5.10	0.01
Stage 4	0.042	0.8	133.1	0.073	2.52	0.01
Stage 5	0.045	0.8	133.9	0.078	1.41	0.01
Stage 6	0.046	0.8	134.8	0.080	0.75	0.01
Stage 7	0.052	1.0	135.7	0.091	0.40	0.02
Filter	3.500	64.3	200.0	6.092	n/a	1.13
TOTAL	5.444	100.0	100.0	9.476	n/a	1.76

******** PILAT DATA REDUCTION ********

(datafile=sd_pilat)

Plant	South Dakota Cement
Run Number	P-14 (extractive)
Date of Run	13-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port C
Impaction Substrate	Stainless Steel
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	11:25
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	75
Barometer (inches Hg)	26.30
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.72
Delta H (inches H2O)	0.50
Volume of Gas Sampled at Meter Conditions (ft3)	25.610
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	93.9
Average Stack Temperature (degrees Farenheit)	489.0
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.43
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.3
Assumed Moisture in Stack Gas (percent by volume)	8.6
Isokinetic Rate (percent)	179.1
Gas Sampling Rate at Stack Conditions (ft3/min)	0.762
Volume of Gas Sampled at Normal Conditions (ft3)	20.414
Volume of Gas Sampled at Normal Conditions (m3)	0.578
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6537147
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185111
Mass Emission Rate at Standard Conditions (lb/hr)	1.02
Mass Emission Rate at Standard Conditions (kg/hr)	0.50

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.143	9.1	109.1	0.247	17.61	0.05
Stage 2	0.064	4.1	113.1	0.111	13.26	0.02
Stage 3	0.042	2.7	115.8	0.073	5.07	0.01
Stage 4	0.060	3.8	119.6	0.104	2.51	0.02
Stage 5	0.037	2.3	122.0	0.064	1.40	0.01
Stage 6	0.032	2.0	124.0	0.055	0.74	0.01
Stage 7	0.066	4.2	128.2	0.114	0.40	0.02
Filter	1.132	71.8	200.0	1.958	n/a	0.36
TOTAL	1.576	100.0	100.0	2.726	n/a	0.50

******** PILAT NH4Cl DATA REDUCTION ********

(datafile=sd_nh4cl)

Plant	South Dakota Cement
Run Number	P-2
Date of Run	05-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port C
Impaction Substrate	Quartz (NH4Cl)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	11:30
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	70
Barometer (inches Hg)	26.36
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.72
Delta H (inches H2O)	0.16
Volume of Gas Sampled at Meter Conditions (ft3)	15.200
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Farenheit)	75.3
Average Stack Temperature (degrees Farenheit)	334.5
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	60.5
Assumed Moisture in Stack Gas (percent by volume)	11.9
Isokinetic Rate (percent)	104.6
Gas Sampling Rate at Stack Conditions (ft3/min)	0.406
Volume of Gas Sampled at Normal Conditions (ft3)	12.554
Volume of Gas Sampled at Normal Conditions (m3)	0.355
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6882754
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	194898
Mass Emission Rate at Standard Conditions (lb/hr)	0.27
Mass Emission Rate at Standard Conditions (kg/hr)	0.13

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.018	7.5	107.5	0.051	22.57	0.01
Stage 2	0.012	5.0	112.5	0.034	17.01	0.01
Stage 3	0.042	17.5	130.0	0.118	6.52	0.02
Stage 4	0.039	16.3	146.2	0.110	3.24	0.02
Stage 5	0.027	11.3	157.5	0.076	1.82	0.01
Stage 6	0.042	17.5	175.0	0.118	0.97	0.02
Stage 7	0.036	15.0	190.0	0.101	0.53	0.02
Filter	0.024	10.0	200.0	0.068	n/a	0.01
TOTAL	0.240	100.0	100.0	0.675	n/a	0.13

******** PILAT NH4CI DATA REDUCTION ********

(datafile=sd_nh4cl)

Plant	South Dakota Cement
Run Number	P-4
Date of Run	05-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz (NH4CI)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	17:25
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	70
Barometer (inches Hg)	26.36
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.92
Delta H (inches H2O)	0.20
Volume of Gas Sampled at Meter Conditions (ft3)	16.803
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Farenheit)	82.8
Average Stack Temperature (degrees Farenheit)	349.3
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.50
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	69.1
Assumed Moisture in Stack Gas (percent by volume)	12.0
Isokinetic Rate (percent)	101.9
Gas Sampling Rate at Stack Conditions (ft3/min)	0.452
Volume of Gas Sampled at Normal Conditions (ft3)	13.688
Volume of Gas Sampled at Normal Conditions (m3)	0.388
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7699966
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	218039
Mass Emission Rate at Standard Conditions (lb/hr)	0.25
Mass Emission Rate at Standard Conditions (kg/hr)	0.12

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.033	15.1	15.1	0.085	21.55	0.02
Stage 2	0.018	8.3	23.4	0.046	16.23	0.01
Stage 3	0.030	13.8	37.2	0.077	6.22	0.02
Stage 4	0.003	1.4	38.5	0.008	3.09	0.00
Stage 5	0.024	11.0	49.5	0.062	1.73	0.01
Stage 6	0.012	5.5	55.0	0.031	0.93	0.01
Stage 7	0.033	15.1	70.2	0.085	0.50	0.02
Filter	0.065	29.8	100.0	0.168	n/a	0.04
TOTAL	0.218	100.0	100.0	0.562	n/a	0.12

******** PILAT NH4CI DATA REDUCTION ********

(datafile=sd_nh4cl)

Plant	South Dakota Cement
Run Number	P-5
Date of Run	06-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz (NH4Cl)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	10:47
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	70
Barometer (inches Hg)	26.44
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.72
Delta H (inches H2O)	0.15
Volume of Gas Sampled at Meter Conditions (ft3)	14.838
Stack Gas Molecular Weight (grams/mole)	31.30
Average Meter Temperature (degrees Farenheit)	101.3
Average Stack Temperature (degrees Farenheit)	486.0
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.57
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.0
Assumed Moisture in Stack Gas (percent by volume)	8.5
Isokinetic Rate (percent)	102.5
Gas Sampling Rate at Stack Conditions (ft3/min)	0.434
Volume of Gas Sampled at Normal Conditions (ft3)	11.722
Volume of Gas Sampled at Normal Conditions (m3)	0.332
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6560326
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185768
Mass Emission Rate at Standard Conditions (lb/hr)	0.36
Mass Emission Rate at Standard Conditions (kg/hr)	0.18

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.033	10.5	110.5	0.099	23.34	0.02
Stage 2	0.024	7.6	118.1	0.072	17.58	0.01
Stage 3	0.036	11.4	129.5	0.108	6.74	0.02
Stage 4	0.050	15.9	145.4	0.151	3.35	0.03
Stage 5	0.039	12.4	157.8	0.117	1.88	0.02
Stage 6	0.047	14.9	172.7	0.142	1.01	0.03
Stage 7	0.039	12.4	185.1	0.117	0.55	0.02
Filter	0.047	14.9	200.0	0.142	n/a	0.03
TOTAL	0.315	100.0	100.0	0.949	n/a	0.18

******** PILAT NH4CI DATA REDUCTION ********

(datafile=sd_nh4cl)

Plant	South Dakota Cement
Run Number	P-6
Date of Run	06-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz (NH4Cl)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	15:05
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	80
Barometer (inches Hg)	26.44
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.72
Delta H (inches H2O)	0.15
Volume of Gas Sampled at Meter Conditions (ft3)	14.638
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	101.8
Average Stack Temperature (degrees Farenheit)	486.0
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.57
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.1
Assumed Moisture in Stack Gas (percent by volume)	8.7
Isokinetic Rate (percent)	101.1
Gas Sampling Rate at Stack Conditions (ft3/min)	0.428
Volume of Gas Sampled at Normal Conditions (ft3)	11.554
Volume of Gas Sampled at Normal Conditions (m3)	0.327
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6556468
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185658
Mass Emission Rate at Standard Conditions (lb/hr)	0.27
Mass Emission Rate at Standard Conditions (kg/hr)	0.13

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.056	24.0	124.0	0.171	23.48	0.03
Stage 2	0.024	10.3	134.3	0.073	17.69	0.01
Stage 3	0.039	16.7	151.1	0.119	6.79	0.02
Stage 4	0.003	1.3	152.4	0.009	3.37	0.00
Stage 5	0.018	7.7	160.1	0.055	1.90	0.01
Stage 6	0.024	10.3	170.4	0.073	1.02	0.01
Stage 7	0.042	18.0	188.4	0.128	0.56	0.02
Filter	0.027	11.6	200.0	0.083	n/a	0.02
TOTAL	0.233	100.0	100.0	0.712	n/a	0.13

******** PILAT NH4CI DATA REDUCTION ********

(datafile=sd_nh4cl)

Plant	South Dakota Cement
Run Number	P-7
Date of Run	06-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz (NH4Cl)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	17:07
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	80
Barometer (inches Hg)	26.44
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.72
Delta H (inches H2O)	0.15
Volume of Gas Sampled at Meter Conditions (ft3)	14.594
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	95.8
Average Stack Temperature (degrees Farenheit)	488.3
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.57
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	66.2
Assumed Moisture in Stack Gas (percent by volume)	8.7
Isokinetic Rate (percent)	102.0
Gas Sampling Rate at Stack Conditions (ft3/min)	0.433
Volume of Gas Sampled at Normal Conditions (ft3)	11.644
Volume of Gas Sampled at Normal Conditions (m3)	0.330
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6548512
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	185433
Mass Emission Rate at Standard Conditions (lb/hr)	0.19
Mass Emission Rate at Standard Conditions (kg/hr)	0.09

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.030	17.9	117.9	0.091	23.38	0.02
Stage 2	0.021	12.5	130.4	0.064	17.62	0.01
Stage 3	0.021	12.5	142.9	0.064	6.76	0.01
Stage 4	0.033	19.6	162.5	0.100	3.36	0.02
Stage 5	0.015	8.9	171.4	0.045	1.89	0.01
Stage 6	0.018	10.7	182.1	0.055	1.01	0.01
Stage 7	0.015	8.9	191.1	0.045	0.55	0.01
Filter	0.015	8.9	200.0	0.045	n/a	0.01
TOTAL	0.168	100.0	100.0	0.510	n/a	0.09

******** PILAT NH4Cl DATA REDUCTION ********

(datafile=sd_nh4cl)

Plant	South Dakota Cement
Run Number	P-9
Date of Run	11-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz (NH4Cl)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	15:05
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	52
Barometer (inches Hg)	26.77
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.69
Delta H (inches H2O)	0.14
Volume of Gas Sampled at Meter Conditions (ft3)	13.280
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	67.5
Average Stack Temperature (degrees Farenheit)	479.4
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.45
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	64.1
Assumed Moisture in Stack Gas (percent by volume)	8.1
Isokinetic Rate (percent)	99.3
Gas Sampling Rate at Stack Conditions (ft3/min)	0.408
Volume of Gas Sampled at Normal Conditions (ft3)	11.303
Volume of Gas Sampled at Normal Conditions (m3)	0.320
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	6524732
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	184760
Mass Emission Rate at Standard Conditions (lb/hr)	0.42
Mass Emission Rate at Standard Conditions (kg/hr)	0.21

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.136	37.6	137.6	0.425	23.99	0.08
Stage 2	0.047	13.0	150.6	0.147	18.08	0.03
Stage 3	0.053	14.6	165.2	0.166	6.93	0.03
Stage 4	0.015	4.1	169.3	0.047	3.44	0.01
Stage 5	0.033	9.1	178.5	0.103	1.94	0.02
Stage 6	0.042	11.6	190.1	0.131	1.04	0.02
Stage 7	0.030	8.3	198.3	0.094	0.57	0.02
Filter	0.006	1.7	200.0	0.019	n/a	0.00
TOTAL	0.362	100.0	100.0	1.131	n/a	0.21

******** PILAT NH4Cl DATA REDUCTION ********

(datafile=sd_nh4cl)

Plant	South Dakota Cement
Run Number	P-11 (extractive)
Date of Run	12-June-1985
Operator	Ken Knapp
Sampling Location	Stack #4 / Port B
Impaction Substrate	Quartz (NH4Cl)
Meter Box Identification	#008691
Delta H@ (inches H2O)	2.12
Meter Correction Factor (dimensionless)	0.950
Start Time	12:30
Length of Run (minutes)	60.0
Ambient Temp. (degrees Farenheit)	54
Barometer (inches Hg)	26.57
Pitot C Factor (dimensionless)	0.850
Delta P (inches H2O)	0.90
Delta H (inches H2O)	0.77
Volume of Gas Sampled at Meter Conditions (ft3)	29.471
Stack Gas Molecular Weight (grams/mole)	31.20
Average Meter Temperature (degrees Farenheit)	65.5
Average Stack Temperature (degrees Farenheit)	337.0
Nozzle Inside Diameter (inches)	0.1400
Relative Stack Static Pressure (inches H2O)	-0.49
Stack Cross-sectional Area (ft2)	61.3
Stack Gas Velocity (fps)	67.6
Assumed Moisture in Stack Gas (percent by volume)	10.7
Isokinetic Rate (percent)	183.3
Gas Sampling Rate at Stack Conditions (ft3/min)	0.795
Volume of Gas Sampled at Normal Conditions (ft3)	25.034
Volume of Gas Sampled at Normal Conditions (m3)	0.709
Dry Gas Discharge Rate at Normal Conditions (ft3/hr)	7831355
Dry Gas Discharge Rate at Normal Conditions (m3/hr)	221759
Mass Emission Rate at Standard Conditions (lb/hr)	0.21
Mass Emission Rate at Standard Conditions (kg/hr)	0.10

	MASS	TOTAL PCT	CUMUL PCT	MG/DNCM	D/50	KG/HR
Stage 1	0.050	15.1	115.1	0.071	16.13	0.02
Stage 2	0.056	16.9	131.9	0.079	12.14	0.02
Stage 3	0.044	13.3	145.2	0.062	4.64	0.01
Stage 4	0.030	9.0	154.2	0.042	2.29	0.01
Stage 5	0.036	10.8	165.1	0.051	1.28	0.01
Stage 6	0.024	7.2	172.3	0.034	0.68	0.01
Stage 7	0.036	10.8	183.1	0.051	0.36	0.01
Filter	0.056	16.9	200.0	0.079	n/a	0.02
TOTAL	0.332	100.0	100.0	0.468	n/a	0.10